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ANNALS
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VOL. 65 MARCH, 1956 No. 1

I

THE CONTROL OF SOUND TRANSMISSION BY THE MIDDLE EAR MUSCLES

ERNEST GLEN WEVER, PH.D.
AND
JACK A. VERNON, PH.D.
PRINCETON, N. J.

One of the early theories of tympanic muscle function was that these muscles, or at least the tensor tympani muscle, serves the purpose of regulating the transmission of sounds through the middle ear. In its complete form this theory asserted that the muscles are able to augment faint sounds and to moderate the intensity of excessively strong ones. Molinettus is credited with the first presentation of this theory; according to Morgagni,[1] he claimed that the tensor tympani muscle excludes strong and uncomfortable noises and amplifies weak ones.

This theory has met with more general acceptance in the limited form known as the protection theory, according to which the ear's efficiency can only be decreased by the muscle action. The formulation of this theory that had the greatest influence was that of Johannes Müller in 1837.[2] Müller suggested that the tensor tympani muscle acts reflexly in response to loud sounds so as to induce a "deadening or muffling of the ears."

Recent evidence had provided strong support for this later version of the intensity-control theory.[3] At the same time, however, the enhancing type of action has not been altogether excluded. Thus the experiments of Wever and Bray[4] in which artificial tensions were

From the Princeton Psychological Laboratory.

exerted on the stapedius tendon of the cat showed that though in general such tensions caused a reduction of transmission, a limited amount of tension, up to about 4 grams, produced an increase of transmission for tones in the region of 2000 cycles. Similar observations were made by Wiggers[5] on the guinea pig during spontaneous contraction of the muscles.

In a recent article on the thresholds of the tympanic muscle reflexes[6] we mentioned some observations of a gain in transmission as a result of excitation of these reflexes. The present report gives further details of the observations.

METHOD AND PROCEDURE

The experiments were carried out in cats that were first anesthetized with sodium pentobarbital and then decerebrated, after which a period of two to three hours was interposed to permit an elimination of the anesthetic and a recovery of reflex excitability.

Both pinnas were removed and a sound cannula was tied into the external meatus of each side. These cannulas led from separate loud-speakers, and each carried a probe tube for the indication of sound pressures delivered to the ear. The auditory bulla was opened on the right side and a platinum foil electrode was placed on the round window membrane for the recording of cochlear potentials. A wave analyzer (a highly selective voltmeter) was used for the measurement of these potentials. A tone, usually of 450 cycles, was conducted to the right ear and steadily maintained at an intensity that in the absence of reflex activity produced a cochlear potential of 50 microvolts. Then reflex activity was elicited by stimulating the left ear with tones of various frequencies over a range of 100 to 10,000 cycles. In this stimulation an electronic switch was used to give a clickless presentation with an onset time of five milliseconds and a duration of about two seconds. The stimulating tones were presented first at low intensities and then were raised by small steps until a reflex action of the middle ear muscles was indicated by a change in the magnitude of the cochlear potentials obtained from the right ear. The stimulation was raised further in steps of 1 or 2 db, with observation of the nature of the changes in transmission, and this procedure was continued until the effect became stabilized or until the intensity level was so high as to endanger the ear. Previous work on the cat has established that contralateral stimulation as used here is as effective in eliciting the tympanic muscle reflexes as stimulation of the ear in which the muscle action is being observed. This contralateral form of stimulation was adopted because at the levels concerned it does not produce any interference with the cochlear potentials that are being recorded.[6]

At times the muscle action was further studied by means of a strain gauge attached by a thread to the tensor tympani tendon, and also by visual observation of this muscle through a microscope giving 15 times magnification. The strain gauge had a minimum sensitivity of three milligrams.

The experiments were carried out on 29 cats, of which 26 were studied systematically throughout the frequency range and three were studied only for a limited range.

RESULTS

The animals showed large individual differences in the effects of the reflex action. In 7 of the 29 animals the only effects were diminutions of transmission as indicated by the potentials recorded from the right ear. In the remaining 22 animals there were increases of transmission also, but these animals varied greatly as to the stimuli in the left ear that caused these increases. In 5 of these animals the increases appeared only in response to a narrowly limited range of tones, usually in the region of 1500 cycles. In 7 others these effects appeared only for the upper range of tones, from 1000 to 10,000 cycles or sometimes from 500 to 10,000 cycles. In a single animal they appeared only for the lower range of tones, up to 1500 cycles. In 5 animals the increases appeared in response to all tones from 100 to 10,000 cycles.

In the animals in which increases of response were found for at least some of the stimulating tones the changes of potential typically passed through three phases, which we designate as the "gain," "indifferent," and "loss" phases. The first or gain phase begins with a barely noticeable increase of potential; and the intensity required at this point is defined as the gain threshold. As the intensity is raised in successive steps above this threshold the increase of potential becomes greater and finally reaches a maximum from which it falls abruptly toward zero. The maximum gain is usually of the order of 1 or 2 db. As the stimulation is continued a second or indifferent phase begins which is characterized by great variations. In some animals the potential remains unchanged on the application of stimuli over an extent of 4 to 6 db in this region. In other animals the response shows rapid fluctuations usually of small magnitude, sometimes rising, then falling, and finally returning to zero, or else falling, then rising, and likewise ending at zero. A further increase of stimulus intensity brings in the third and final phase, the loss phase, in which a definite decrease of potential appears and steadily grows larger as the stimulation is made stronger. The smallest intensity required to produce a change of potential that ends as a decrease (even

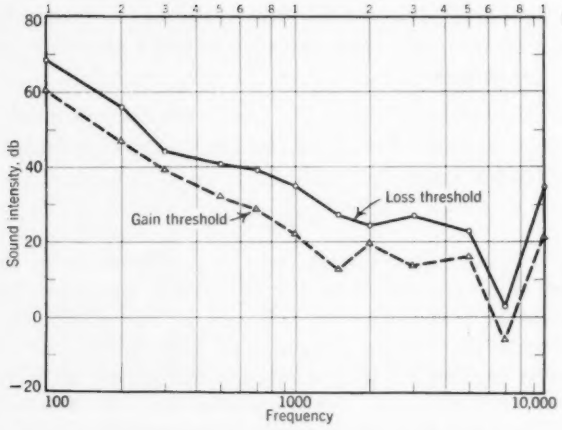

Fig. 1.—Gain and loss thresholds in a typical animal. The sound intensity is represented in decibels relative to 1 dyne per sq cm. (Cat No. 1099)

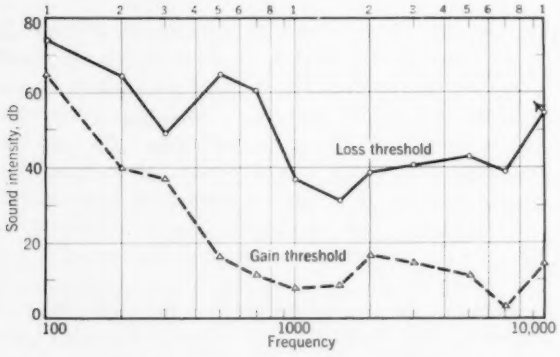

Fig. 2.—Gain and loss thresholds showing unusually wide differences. The arrow at the 10,000 cycle point on the upper curve indicates that this intensity was reached without a loss threshold being found. (Cat No. 1095)

though in some instances there may be an initial wave of increase) is defined as the loss threshold. With rare exceptions these loss thresholds were found for every animal and for every frequency within the range studied. The exceptions occurred in certain animals at 10,000 cycles, at which frequency the potential continued to show an increase for all intensities that were considered safe to apply to the ear.

A comparison of gain and loss thresholds obtained in a particular animal is made in Figure 1. Here the minimum intensities necessary to produce the two types of threshold are represented in decibels relative to one dyne per sq cm. The two curves have much the same form, but differ in level by amounts varying from 4 to 14 db without any significant relation to frequency. The average difference is 9.3 db. These results are representative of most of the animals in which increases of potential were found for all or the major part of the frequency range.

At times the differences between the two thresholds are much larger, as shown in Figure 2. Here the differences vary from 9 to 49 db, with an average of 29 db. The unusual size of these differences is mainly due to the low gain thresholds.

In three animals, after observations had been made under the usual conditions, the stapedius tendon was severed in the right ear and the stimulation procedure was repeated with only the tensor tympani muscle in action. In all three the effects of the reflex were significantly altered. One of these animals, which had shown increases of potential for tones between 100 and 1500 cycles when both muscles were acting, showed these increases only in the range from 600 to 1000 cycles after the stapedius tendon was severed. The other two animals gave no increases of potential at any frequency when the middle ear muscles were intact, but after elimination of the stapedius muscle one of them showed increases in a narrow region from 800 to 900 cycles and the other showed increases at 3000 and 10,000 cycles.

In five animals the usual measurements were carried out with the muscles intact and then the bony spicule that forms the attachment of the tensor tendon was clipped off, leaving only the stapedius muscle in action. Again the reflex effects were considerably modified. In one of these animals increases of potential had been observed for stimulating tones between 700 and 4000 cycles, but after elimination of the tensor tympani muscle no increases were found at any frequency. In another animal increases had been observed for the high tones from 4000 to 10,000 cycles, and likewise after elimination of

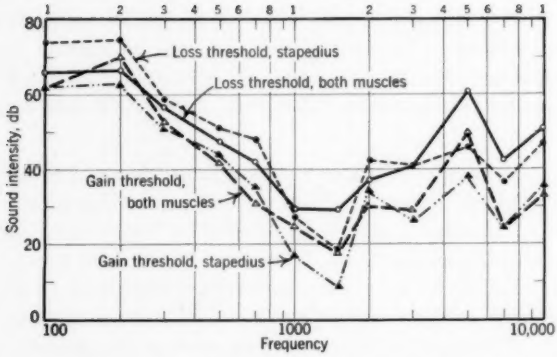

Fig. 3.—Gain and loss thresholds for the two muscles and for the stapedius muscle alone. (Cat No. 1096)

the tensor no increases were found. In the third animal no increases were observed at first, but after elimination of the tensor increases were obtained for tones between 500 and 10,000 cycles. In the fourth animal increases were observed for all tones both before and after elimination of the tensor. In the fifth animal only limited tests were made before eliminating the tensor, and afterward increases were found for the range of 3000 to 7000 cycles.

Results for the fourth animal mentioned above are given in detail in Figure 3. The gain threshold curves for both muscles together and for the stapedius muscle alone cross one another several times, and are noticeably different only at 1000, 1500, and 5000 cycles. The two loss threshold curves show larger differences, but the variations are such as to make a relation to frequency uncertain.

The observations show in general a modification of the reflex effect upon transmission as a result of the elimination of one of the tympanic muscles. They show further that either muscle acting alone is capable of producing a gain in transmission as well as a loss.

We have attempted by the use of the strain gauge to discover the nature of the action of these muscles under the conditions that give increases of response. This gauge was applied so as to register changes in tension along the line of the tensor tympani tendon. Such changes are expected to represent chiefly the activity of the tensor tympani muscle, but a contribution by the stapedius muscle cannot be ruled out.

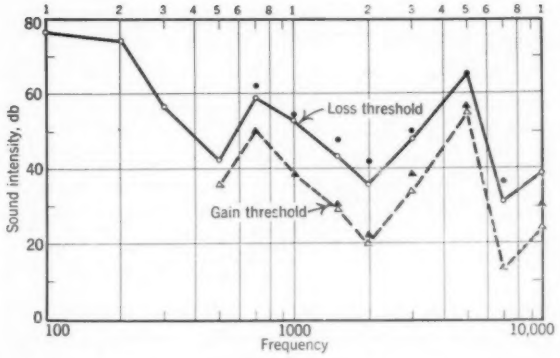

Fig. 4.—Gain and loss thresholds in relation to tensions recorded along the line of the tensor tendon. Gain thresholds: open triangles connected by the broken line. Loss thresholds: open circles connected by the solid line. Decreases of tension: solid triangles. Increases of tension: solid circles. (Cat No. 1094)

We encountered difficulties in the measurement of these tensions under the conditions giving gains of potential, for the muscle action is weak at these levels of stimulation and often is of the same order of magnitude as the random fluctuations of muscle tonus. Also at these levels the reflex action is variable even when precautions are taken to avoid adaptation and fatigue. In spite of these difficulties we made a number of observations of what seemed to be definite reductions of tension as recorded by the strain gauge coincident with our measurement of a gain in cochlear potentials. In many more instances, however, the gains of cochlear potential were accompanied by increases of tension. It appears that under suitable conditions either an increase or a decrease of tension can produce an improvement of transmission.

Figure 4 shows results from one of our exceptional animals in which there were regular decreases of tension in response to tones over a wide range, from 700 to 10,000 cycles. These decreases first appeared when the stimulation was raised to the levels indicated by the solid triangles. Observations were made also of the levels at which a gain in cochlear potentials was first observed, and these gain thresholds are indicated by the open triangles through which the broken line is drawn. As may be seen, these two sets of points are closely similar. When the stimulus intensity was raised further the

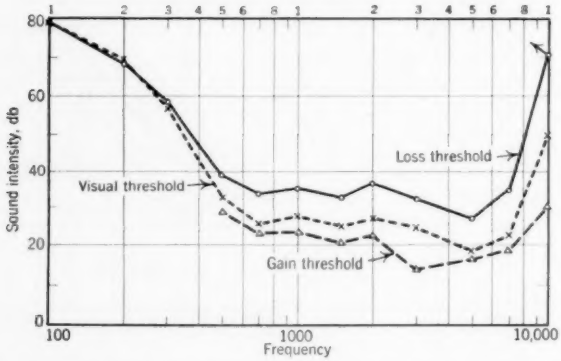

Fig. 5.—Gain and loss thresholds in relation to visual thresholds. The arrow at the 10,000 cycle point on the upper curve indicates that this intensity was reached without a loss threshold being found. (Cat No. 1112a)

action changed to an increase of tension, and the threshold levels for this increase are indicated by the solid circles. Also the thresholds for decreases of cochlear potential (loss thresholds) are indicated by the open circles through which the solid line is drawn. No strain gauge changes could be observed below 700 cycles, and no gain thresholds were obtained below 500 cycles. Also, no increase of tension could be obtained at 10,000 cycles. But apart from these limitations a clear relation is found between gain thresholds and decreases of tension and between loss thresholds and increases of tension.

Our visual observations of the activity of the tensor tympani muscle indicate contractions coincident with both increases and decreases of cochlear potential. The contractions are not usually visible at the gain threshold, but often appear when the stimulation is raised 4 to 6 db above this threshold, when the response is still in the gain phase and usually is close to the maximum of that phase.

Figure 5 gives a comparison of visual thresholds and both the gain and loss thresholds as seen in the cochlear potentials. It will be noted that over most of the frequency range the muscle contractions became visible at stimulus intensities lying between those required for the two types of cochlear potential thresholds, but in general these intensities were closer to the gain thresholds. For the lowest tones, however, this animal gave no gain thresholds and the visual thresholds were coincident with the loss thresholds.

COMMENT

These experiments show that in the cat a reflex action of the tympanic muscles can enhance as well as reduce the transmission of sounds by the middle ear. Our results were obtained mostly with 450 cycles as the test tone, but other tones were used sufficiently to show that these changes in transmission are of a general nature, affecting all tones. The effects are not the same in amount when different test frequencies are used, but the details of these variations within the gain phase have not been fully explored. The variations within the loss phase as a function of the frequency and intensity of the test tone were reported earlier.[7]

These results indicate that the manner of contraction of the two muscles in combination, and of either muscle by itself, is subject to change according to the frequency and intensity of acoustic stimulation. The strain gauge observations indicate that the action along the line of the tensor tendon can consist of a reduction of tension as well as an increase. Whether this reduction of tension represents an actual relaxation of the muscle or a contrary action of different groups of its fibers has not been ascertained. No relaxations were revealed by the visual observations, but they could have occurred without being obvious.

The visual observations indicated a regular alteration in the form of the action of the tensor tympani muscle according to stimulus intensity. We had the impression that the contractions in the gain phase were not of the muscle as a whole but of its more medial portion. This portion has a direction of pull nearly at right angles to the tensor tendon and opposite to the stapedius muscle. It therefore may be expected to have an effect upon transmission different from that of the main body of the tensor. As the stimulus intensity is raised the contraction grows progressively stronger, and as the loss threshold is reached it is a vigorous action involving the whole muscle.

It is easy to account for a gain in transmission as a result of a reduction of muscle tension, for such a reduction can be expected to bring about a diminution in the damping of the ossicular chain. The observation of a gain in transmission coincident with an increase of muscle tension was much more common, however. For an explanation of this effect we can suggest either the elimination of looseness in the coupling of the ossicles or an alteration in the resonance characteristics of the system.

These results indicate that the neural patterns governing the reflex action of the two muscles are highly complex in nature, and

that the pathways and connections differ according to the frequency of stimulation.

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DEPT. OF PSYCHOLOGY

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II

HYPERSENSITIZATION OF TISSUE TO INFECTIONS AND ALLERGIC REACTIONS

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In all diseases changed blood flow takes place in the capillaries of the organs affected. The importance of microcirculatory change as a cause rather than a result of pathology is usually ignored. I believe that more study of the small blood vessels may result in better understandng of symptoms as well as disease (Figs. 1 and 2).

The hypersensitization of small blood vessels will be discussed in this paper because this is germaine to the understanding of the occurrence, recurrence, intensity and localization of infectious, allergic and incidentally many other diseases. For example, the so-called psychosomatic diseases are especially concerned with reflexes which change (most often they stagnate) the capillary flow in the organ affected. After blood stasis increased capillary permeability, edema, hemorrhage, phagocytosis, followed by more or less necrosis and finally healing usually occur. There must be things which tend to initiate these phenomena in one area, or one organ rather than another.

In 1903 Meltzer and Auer[1] demonstrated that removal of the superior cervical ganglion supersensitizes the vascular flow in rabbit auricles (Fig. 3). Ordinarily the sympathectomized side is slightly more engorged than the normal side, but during fright the sympathectomized side, after a few days, shows excessive constriction of the vessels and therefore greater paleness of the entire auricle. In 1905 Elliott[2] demonstrated a similar phenomenon in the so-called "paradoxical pupil in cats." This is an increased dilation of the pupil with intravenous epinepherine when the cervical sympathectic has been cut and removed for a week or more; in spite of the expected lack of reaction because of the removal of the normal excitor pathways; and in spite of the narrowed pupil before injection of the epinepherine.

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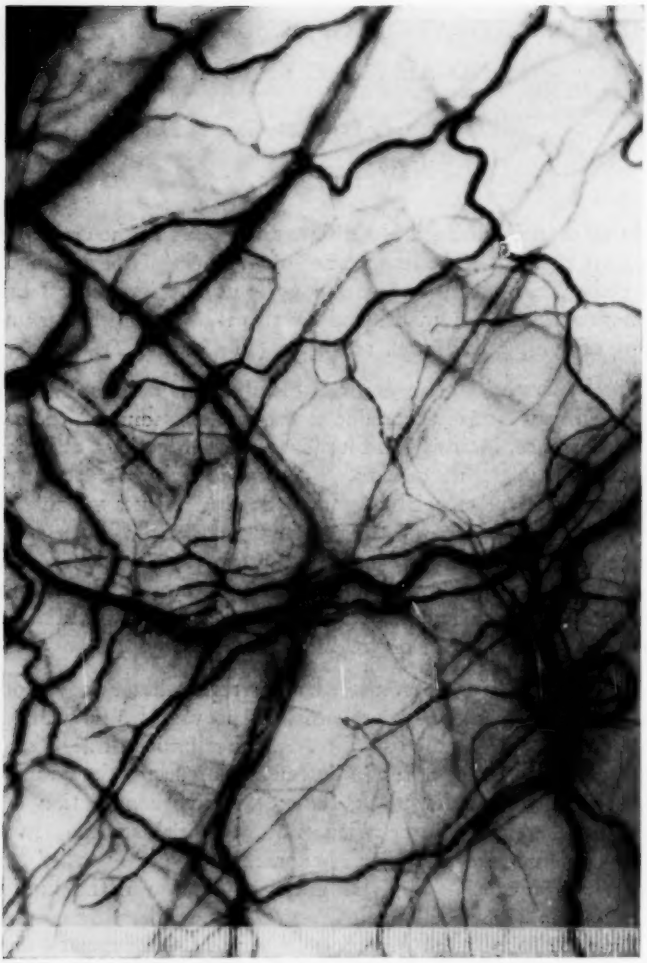

Fig. 1.—Conjunctival vessels of patient with Ménière's Disease—between attacks. Note complexity of relatively normal vascular pattern and flow although one group of vessels show a very lumpy flow. Divisions on scale equal 18 micra. Flash photo 1/2000 sec. 2x3 mm area.

Fig. 2.—Conjunctival vessels of patient with severe anemia and cryoglobanemia. It is assumed that one of the lumps of blood so easily seen here became caught in one of the tiny vessels of the vestibular labyrinth and so precipitated her presenting symptoms of violent vertigo and nausea and vomiting. One division on scale equals 18 micra. Flash photo 1/2000 sec. 2x3 mm area.

Cannon then showed that this type of hypersensitivity could best be demonstrated if submaximal doses of the incitor were used and that although it occurred most strongly with a chronic post-ganglionic denervation, but that it also occurred with preganglionic and slightly with central interference to the nerve supply. In addition to injection of epinepherine, with injections of pilocarpine, histamine and many other substances there was increased and more prolonged constriction, contraction, dilation or relaxation, as the case might be, in all organs studied. Similarly, Dale and Gasser[3] demonstrated that denervated skeletal muscle is supersensitized, not only to acetylcholine but also to potassium ions, after denervation.

Following these basic experiments Cannon and Rosenblueth compiled a monograph which indicated from their own and other authors' experiments that denervation produced hypersensitivity of any organ to any drug and they called this their "Law of Denervation."[3]

If this "law of denervation" is correct, symptoms from hypersensitization should occur in patients with denervated or partially denervated organs or parts of organs but neither of these men, nor the authors they quote, went further than physiological reactions in animals. It seems meet therefore to point out some of the clinical applications of their observations and conclusions to disease states not only in animals but also in man.

In 1938 I first saw a patient who showed clinical manifestations of hypersensitization of the nasal passages from denervation.[4] Ablation of her sympathetic nerve supply to one side of the head by stellate ganglion resection caused a Horner's syndrome and paradoxical pupil. Her nasal mucosa on that side had the typical appearance of an allergic nose. The secretions were watery, the nasal mucosa was pale, purplish pink with a boggy consistency. The secretions contained 90 per cent eosinophiles. In sharp contrast the other side was normal. The nasal condition, on the sympathectomized side was made worse by emotion, cold, draught or local irritation. Before operation she was slightly ragweed sensitive but after the sympathectomy she had severe ragweed reactions on the denervated side. I have seen several other patients with Horner's syndrome from post-ganglionic cervical interruptions who had similar unilateral vasomotor rhinitis.

Note that with interference to the sympathetic control to the blood vessels these patients manifested typical symptoms and signs of allergy. This suggests that allergic symptoms, including incidentally an increase in eosinophiles, can be produced by altered sympathetic activity, and that altered activity can be independent of any antigen-antibody reactions. Typical allergic symptoms and signs occurred in

Fig. 3.—Vessels of the pinna of a rabbit during anesthesia, ten days after right cervical sympathectomy. Note dilation of vessels on right side.

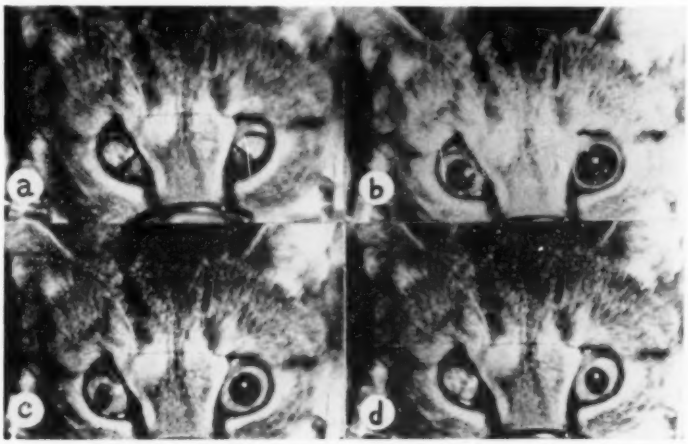

Fig. 4.—The paradoxical pupil phenomenon which with similar action of the nictitating membrane clearly demonstrates the "Law of Denervation" as cited by Cannon and Rosenblueth. Compare with Figs. 2 and 3. a) Cat under nembutal anesthesia ten days after left cervical sympathectomy. b) Same cat after ½ cc of 1:1000 adrenalin hydrochloride intravenously. c) After ½ cc of 1:10,000 adrenalin intravenously. d) After ½ cc of 1:1,000,000 adrenalin intravenously. Courtesy of Annals of Allergy.

the first patient cited, whether the stimulus was of classic allergic type, i.e., from ragweed, or whether the stimulus was a physical allergy, i.e., from cold, or whether it was precipitated by emotional stress. This demonstrates a basic concept, namely, that allergic symptoms come primarily from autonomic nervous system imbalance rather than from antigen-antibody reactions, per se, and probably explains how Holmes et al.[5] were able to influence the intensity of ragweed hay fever by psychic stimuli.

In a further attempt to authenticate the observations suggesting that autonomic imbalance is of basic importance in "allergy"[6-8] let us look at a laboratory experiment using the classical allergic response known as the Shwartzmann "phenomenon." If exactly 0.02 cc of a broth filtrate of Salmonella typhosa culture is injected into the skin of each ear of a normal rabbit and then 24 hours later 2 or 3 cc of the same filtrate is injected intravenously, equal hemorrhagic necrotic areas will appear around the injection sites in 5 to 6 hours (Fig. 5).

Now if a rabbit's ear is sympathectomized by removal of the superior cervical ganglion and equal intracutaneous doses of gram negative culture filtrate in each pinna is followed 24 hours later by an intravenous injection of an antigen, there will occur a much larger reaction on the sympathectomized auricle than on the non-sympathectomized auricle (Fig. 6). This reaction will last much longer than in non-sympathectomized ears (Fig. 7). If the central nerve to the pinna, rather than the sympathetic chain in the neck, is cut on one side, again an enhanced skin necrosis will occur on that side. Thus distant denervation enhances the classical Shwartzmann phenomenon.

To cite another series of experiments along the same lines, if a rabbit is sensitized with crystalline egg albumin, according to the classical method of Arthus[10] until a necrotic reaction begins to occur in the flanks, and exactly 0.02 cc of the solution is injected into the skin of each pinna, while the remainder of the dosage necessary to produce reaction is injected into the flank, there will occur a typical Arthur phenomenon of equal size at the sight of injection in each auricle. However, in sympathectomized animals, after four to ten days, the reaction to the egg albumin in the auricles is very much larger on the sympathectomized side, in spite of the fact that precisely the same intracutaneous dose had been injected into each ear.[11]

With local infection we have much the same story. If small but equal quantities of a properly selected dilution of culture of pneumococcus or hemolytic streptococcus is injected intracutaneously into the pinna of a unilaterally sympathectomized rabbit the inflammatory reaction and the size of the abscess at the injection site is practically

Fig. 5.—Equal Shwartzmann reaction from 0.02 cc of gram negative filtrate in each ear, 24 hours after 3 cc of intravenous filtrate initiated hemorrhagic necrosis.

Fig. 6.—Increased Shwartzmann reaction in sympathectomized ear 24 hours after intravenous injection. Compare control ear and Fig. 5.

Fig. 7.—Increased Shwartzmann reaction in sympathectomized ear 12 days after intravenous injection. Again note dilated vessels on right side. Compare Fig. 3.

Fig. 8.—Increased reaction to pneumococcus in sympathectomized ear two days after intravenous injection of living broth culture.

Fig. 9.—Drawing of an experiment on cat's eye. Five minutes after 0.5 cc injection of epinepherine 1:1000 into the femoral vein (mag. 50 x). a) Point where piece of hair had rested for five minutes. Edema with no blood movement. b) Area traumatized by back of scissors when cutting lids for better exposure. Note diapedesis of red cells and complete stasis in capillaries. Vessels between A and B showed sluggish circulation still. Vessels elsewhere had recovered. (Courtesy of Acta-Oto-Laryngologica)

always greatest on the denervated side (Fig. 8). The reaction is equal in 85 per cent of control animals.

These experiments should suffice to demonstrate that both allergic reactions and infectious reactions are enhanced by denervation. The intensity of these reactions is primarily a function of the small blood vessel supply to the area involved. This is clear from the classical histological picture of each. Edema, and perhaps the tissue hemorrhage, is more marked in the allergic reactions while necrosis and phagocytosis is more pronounced with infections, but no one can deny that both are largely concerned with what goes on in and around the capillaries, and that these in turn are controlled by precapillary sphincters and by constriction or dilation of the metarterioles and venules supplied by the larger vessels.[12]

However, hypersensitization is not only produced by distant nerve trunk or central nervous system interference. Cannon and Rosenbleuth reported hypersensitization from cocaine, which is believed to act locally. Local injury certainly seems to sensitize a tissue as well. For example, if a tiny hair is left on the conjunctiva of the

eye of a cat for ten minutes, and then washed away, everytime this cat is injected intravenously with adrenalin, or is subjected to pain or shock, the area where the hair lay will become blocked with blood and the block will be greater and last longer than blockage in the surrounding normal areas of the conjunctiva (Fig. 9). Furthermore, this blocked area occurs with very much weaker dilutions of epinepherine after injury while other areas of the eye maintain normal flow. It must be remembered that the conjunctiva is a very sensitive tissue and is well supplied with nerve elements so that perhaps it is the tiny filaments to the end organs which are affected by the injury locally rather than the end organs themselves. In slow motion picture, using the mesentery of the rat or cat, it can be shown that lightly stroking the wall of the blood vessel will soon stop the flow in it by one of five mechanisms: 1) a red clot will form in it, 2) a mass of white cells will form in it, 3) a mass of platelets will form in it, 4) there may be a combination of these plugs, 5) there is narrowing of the vessels having muscle fibers. In surrounding tissues there soon occurs a dilation of vessels, especially the venules. The phenomenon described for the cat's mesentery is most easily produced when the injury is near some of the main vessels. This is where the nerve trunks lie. On the other hand, in fertilized chick eggs blockage of circulation also occurs with local trauma to the allantoic membrane[13] but here there are no nerve elements (Fig. 10). Therefore we can not be certain that local sensitization after local trauma is due to nerve injury alone. In fact it would seem that local non-neural factors also are involved in such traumas. Note that here we have briefly described an experiment with embryonic blood flow which when applied to a chick or transferred to an opossum embryo might open up a whole new field in the study of congenital anomalies and malformations. These must be dependent on proper small blood vessel flow during their development.

To go back to our original theme, there is ample clinical documentation of the fact that local tissue injury as well as nerve injury seems to hypersensitize a tissue, making it more liable to recurrence of the previous symptoms and pathology. Perhaps the most homely example is the supersensitivity to cold in an ear or a toe, which occurs after frost bite. Then we have the development and recurrence of osteomyelitis in the tibia after bumping the shin once. Perhaps the pain in an old soldier's wound is another case in point. One wonders about erysipelas, recurrent maxillary sinusitis and a host of other inflammatory diseases. Can not the first infection injure the nerve supply or produce the same sort of injury to the tissues as does direct trauma and thus make for the recurrence of infection? After all infection produces much the same reaction as trauma. One could

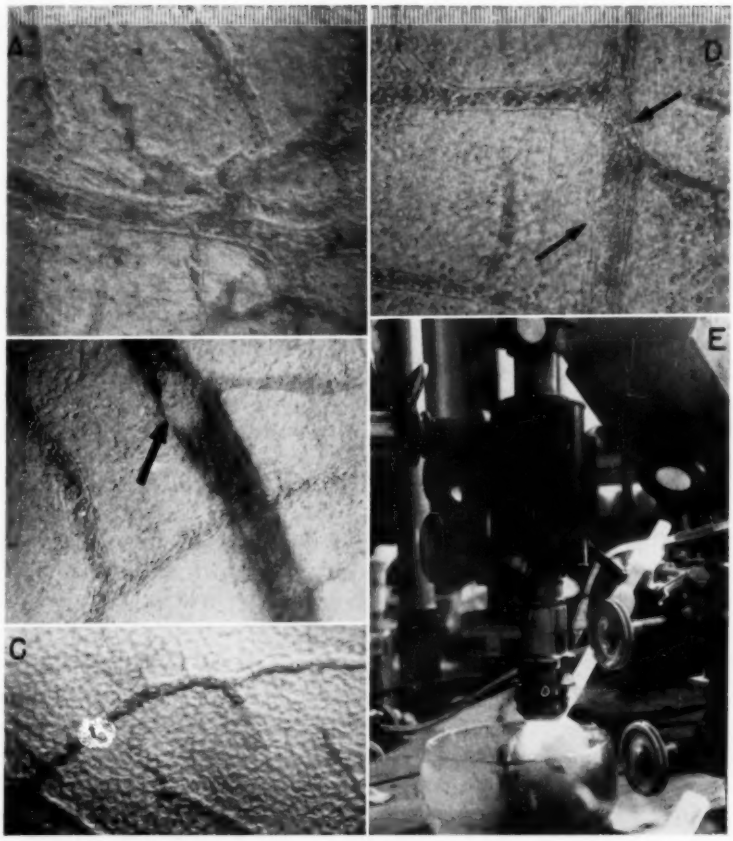

Fig. 10.—a) Normal flow 1/50 sec. b) "White thrombus" stuck to wall of blood vessel. c) No flow after drying. Note primitive capillary net. d) White thrombus moving with slow flow. Compare Fig. 12. e) A set up for photography of vascular flow in chorioallantoic membrane of chick. Scale division approx. 12 micra. Photographs by John Rathe.

argue that denervation could also produce hypersensitization to immune substances and perhaps that is why reduced reaction sometimes develops after repeated infections, but we have no data to this effect.

Now how about increased susceptibility to those diseases in which allergies and infections are not definitely known to play a part? What about the so-called "psychosomatic diseases"? What about the collagen diseases? What about the circulatory diseases themselves? If denervation and local trauma so powerfully hypersensitizes small blood vessel reactions, should they not also be an important factor in the production of diseases already known to be due to changes in circulation, Ménière's diseases,[14] glaucoma, migraine, essential hypertension, thrombosis, arteriosclerosis, etc.? What happens in the ear and in the eye, the stomach, the bowel, the skin and the joints when adrenalin flows into the blood stream from the adrenal glands under the stimulus of pain, rage or frustration? What happens to the tiny blood vessels in the walls of the heart and the walls of the larger blood vessels with such stresses (Fig. 11)? The precapillary sphincters must shut down there just as they do in other tissues of the body. The blood becomes lumpy with red and white cell blockages and there must be, at least, a temporary local anoxia, capillary permeability must change, hemorrhage, edema and local reactions must develop. If the stimulus is severe enough, or if check and balance factors do not come into play, or if they overact, the small blood vessel circulation is changed for a sufficient length of time to cause an irreversible pathology (Fig. 12). I believe that by study of the small blood vessels and their control we may discover a key to many more and maybe all disease.

In summary, Elliott, Cannon and Rosenblueth, and others, have shown that various tissues, including small blood vessels can be supersensitized by denervation. It is demonstrated that the "law of denervation" holds for the small blood vessel reactions in vasomotor rhinitis, the Arthus phenomenon, the Shwartzmann reaction, superficial inflammatory processes, as well as abscess formation. Some of the same blood vessel reactions that develop with nerve trunk denervation can be produced denervation as well as previous local trauma or infection may hypersensitize a tissue to subsequent outflows of adrenalin or other hormones or chemicals. Thus infection, allergies and psychosomatic diseases may be precipitated in a given organ. The mechanism seems to be highly dependent on the lumen of the smaller vessels in the involved part of the suffering organ. A change of caliber can be produced by mural red or white thrombi inside of the vessels as well as by muscle fibers outside of the vessels. There are concomitant changes in capillary permeability followed by the

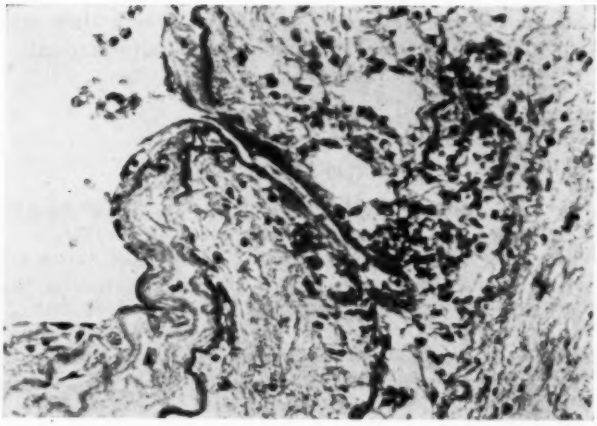

Fig. 11.—Capillary in coronary artery. 160 x. (From Boyd Textbook of Pathology, 1953, Fig. 175)

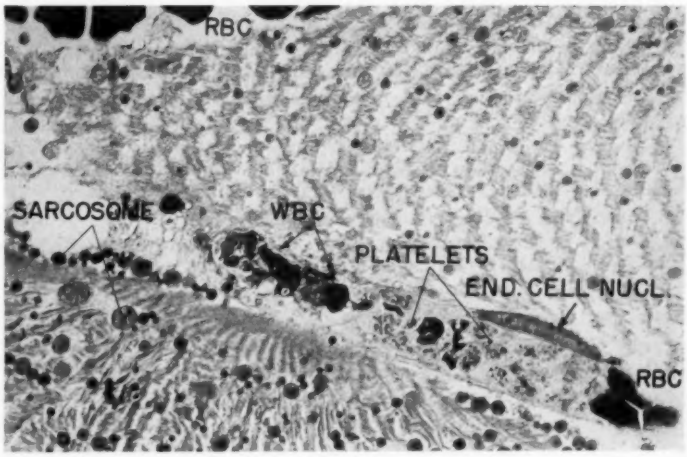

Fig. 12.—Blocked capillary in leg muscle of mouse after it had been made ischemic for two hours with a tourniquet which was then released for 16 hours before fixation with OSO_4. Approx. 3500 x. (Courtesy Dan H. Moore, Department of Microbiology. Electron Microscope photograph.)

classical inflammatory reactions in more or less degree, and the eventual development of permanent pathological tissue, may take place at all ages in all tissues, even embryonic tissue where they may even account for certain congenital anomalies and malformations.

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III

A NEW TECHNIQUE FOR BONE CONDUCTION TESTING

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When Lempert devised the endaural fenestration, bone conduction became more important than ever before. So long as the operation was limited to cases of stapes fixation with normal bone conduction, problems of technique were of greatest importance. Subsequently this limitation was broadened to included selected cases of mixed deafness. Bone conduction which has always been the most satisfactory method of estimating the function of the perceptive system then became the basis for classifying patients as good, fair or poor operative risks.

Bárány and Békésy[1,2] first recognized certan uncontrolled variables which challenge the validity of bone conduction thresholds. Békésy found two important sources of error could be controlled by changing the position of the stimulus from the mastoid to the forehead and measuring the sound pressure transmitted to the bone. His investigations, published in 1932 and 1939, indicated that measurements of sound pressure were much more exact than those of amplitude. The stimulus was applied to the middle of the forehead because the area in which determinations will remain accurate is larger and small displacements of the receiver do not appreciably affect the results. The technique required considerable extra equipment and has not become a practical procedure in clinical or office audiometry.

A committee on the study of bone conduction made its report to the American Otological Society in 1936. The various aspects of bone conduction were investigated. Guild[3] reported on the transmission pathways from various areas of the skull to the labyrinth. He found that a stimulus applied to the mastoid is the most direct and entails the least loss of energy. This position was not wholly acceptable to him because it failed to distinguish between a true perceptive deafness and a simulated one caused by lesions of the osseous trabeculae. In substance, nerve deafness might be indicated when none existed and the most efficient pathway might not be the

most accurate. The final recommendation of the committee however was for approval of this method.

It is always possible for undetected errors to creep in during a test for bone conduction thresholds. Lierle and Reger[4] and Hirsh[5] have mentioned tremor, fatigue, shift in position and alteration of static pressure as uncontrolled factors which influence the results unfavorably. In order to avoid these, Lierle and Reger constructed a special felt-padded headband attached to a metal superstructure with adjustments for maintaining position and static pressure. Comparisons made between thresholds for forks and bone vibrator revealed no discrepancies between the two methods. The audiometer was preferred for its greater range of frequencies and intensities. This headband, which was devised for laboratory research, has not caught on in clinical audiometry but the need for one which will provide duplication of position and static pressure still exists.

Carhart and Hayes[6] investigated a series of five hundred ears for the purpose of detecting differences between test and retest thresholds for air and bone conduction. They found them equally reliable and disagreed with the general belief that bone thresholds are more variable than those established by air conduction. This has not been an invariable experience in office practice. Bizarre contours which are recognized as faulty occasionally appear in audiograms and in such instances the bone thresholds are disregarded.

Hirsh[5] emphasizes the importance of position and static pressure in the following quotation: "We persist in placing the vibrator on the mastoid process probably because of its proximity to the ipsilateral cochlea. That is, we probably feel that a vibrator on the right mastoid is having its maximum effect on the right cochlea. What we have already said should show that this notion is untenable and that both cochleas are subjected to similar effects no matter where on the skull the vibrating force is applied.

"With this in mind, a better criterion for best placement might be: Where is the bone and other tissue most homogeneous over a reasonable area? Both Bárány and Békésy (1932) have shown such an area to be located on the forehead, and it seems that this might be the best place to apply vibrations for bone conduction testing. The absolute threshold may be higher than it is when the vibrator is applied to the mastoid process, but the difference will not be very large, and, what is more important, the threshold will remain fairly constant even though the vibrator be moved about slightly. This is clearly an advantage over placement on the mastoid process, where

Fig. 1.

the variability from place to place within a relatively small area is quite large."*

Before the publication of his text in 1952 he had been experimenting with relative levels for thresholds from the mastoid and forehead positions. In a personal comunication he states that this particular research had been interrupted. It is unfortunate that no absolute values had been established. The author is indebted to him for both incentive and encouragement in this investigation; however, no approval of any statement is implied.

In summary, the various authors mentioned above agreed that certain faults existed in applying the vibrator to the mastoid and that static pressure is an important factor in determining thresholds. These factors cannot be given due consideration in office testing. Cumbersome equipment and time-consuming technique are not practical. It is assumed that each one of a series of forks can be applied with the same pressure and at the same spot on the mastoid bone. We disregard the fact that tension within the spring which holds a bone vibrator against the mastoid will vary with the size of each head and that the vibrator may shift somewhat during the test. Békésy[7] finds that a shift of only 2 or 3 mm on the mastoid may alter the threshold

*By permission from *The Measurement of Hearing*, by Ira Hirsh. Copyright, 1952. McGraw-Hill Book Company, Inc.

by as much as 10 db especially when there is considerable variability in hearing at different frequencies. Zwislocki[8] compares bone conduction from the forehead and mastoid in the following quotation: "In my opinion bone conduction measurement on the forehead is more reliable than on the mastoid and may yield diagnostically more significant results."

A simple method of testing bone conduction in the office which will establish thresholds from the forehead and insure a standard static pressure has been devised. The equipment is illustrated in Figure 1. The headband is a rubber belt with a small inflatable bag and self-locking buckle embodied in it. The headband is put on and cinched up loosely, just enough to keep it in place, with the center of the bag opposite the center of the forehead. The vibrator is then placed under the bag which is connected to a sphygmomanomter and inflated to a pressur of 40 mm. The tubing is then compressed tightly close to the headband and the other connections are removed. The equipment for masking is then added as shown in Figure 2. Earphones are placed over both ears. A pad is placed under the receiver on the ear being tested in order to hold it away from the ear and thus eliminate the effect of a closed canal on hearing. A standard static pressure can be applied to each patient by this method. Forty mm was selected because it is comfortable for the patient, sufficient to secure the vibrator firmly and also low enough to act as a buffer against vibrations being transmitted by the headband.

In tests on one hundred ears for thresholds at 500, 1000 and 2000 c.p.s. an average of 10 db more sound pressure was required from the forehead than from the mastoid position. In the audiogram, an adjustment for each frequency may be made by elevating the bone line 10 db in order to correspond with the value of thresholds from the mastoid position.

While this series was being completed information was received that Professor Lüscher of Basel had been testing bone conduction from the forehead for several years. The following quotation is taken from his reply to a letter of inquiry: "Your experiences about testing bone conduction from the forehead are the same as ours. We also found that it is much easier to fix the bone receiver at the forehead and that a little shifting to one or the other side does not change the threshold appreciably. We also found that the difference between forehead and mastoid threshold is about 10 db and fixed it at our audiometer to 10 db."

It is reasonable to presume that thresholds obtained from the forehead would alter the level of masking if it is assumed that any

Fig. 2.

constant level is satisfactory. A constant level of masking noise does not quite jibe with a hearing loss that varies at different frequencies. The purpose of masking is to just isolate the ear under test at threshold intensity. This is accomplished by a constant level of masking noise in normal-hearing individuals or in those whose hearing loss is approximately the same for all frequencies. It is however a common experience for thresholds to vary as much as 20 or more decibels within one octave. In such instances a constant level becomes either too much or too little rather than just enough. For this reason selective masking at each frequency is preferred. Inasmuch as we must accept the statement of the patient for threshold intensity, masking is a psychological phenomenon rather than a purely physical one. Selective masking, then, is the logical parallel to the Rinné, Schwabach, Weber and other tests in which the statement of the patient is accepted.

A considerable amount of data on masking has been accumulated in laboratories for research. It is difficult to transpose this to values for office testing. In research a white noise is used for masking. This is based on a scale in which zero equals zero. In clinical testing a sawtooth noise is generally used in which zero is the level of detectability. There is however no reference level in decibels for the sawtooth noise. Weille and Gargano[9] have stated that the zero level for a sawtooth noise is 20 db greater than zero for white noise. In selec-

tive masking the noise is adjusted so that each pure tone is heard at threshold in the ear under test. Thus the requirements for masking are fulfilled even though we do not know the intensity of the sound pressure in decibels.

Although the validity of bone conduction is still challenged, a technique which is practical for office audiometry and which will insure a duplication of position and static pressure will increase its reliability.

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The author is pleased to acknowledge his indebtedness to the Audiometer Sales Corporation for special equipment and favors during the preparation of this paper.

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IV

CLASSIFICATION AND TREATMENT OF TEMPOROMANDIBULAR JOINT PROBLEMS

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Since 1934 my chief interest has been to tabulate and classify symptoms related to deranged function of the temporomandibular joint. A small group of cases unimproved after dentistry demanded explanation. During the study of this group, masseter muscle tremor, an obscure muscle reaction with psychogenic implications, was identified as important in the etiology of these unimproved cases. Ordinarily tremor has been associated with fear, shock, and neurologic changes. Apart from these conditions, it has usually been unnoticed when the mandibular joint syndrome was studied. When observed, the tremor influenced the result of treatment unfavorably in every case.

A discussion of treatment of diseases of the temporomandibular joint embraces everything from removal of a single source of trismus to surgical attack upon the joint itself. If an accidental movement of the lower jaw, such as a blow to the jaw or a yawn, produces enough irritation within the joint, trismus and otalgia ensue. The treatment is external elastic splinting, local heat and sedative drugs. If the origin is an abscessed tooth or infection of the ear canal, removal of these sources is the solution. If the joint changes are secondary to long standing malocclusion and improper action of the condyle, irreversible changes in the meniscus, cartilage and bone structures of the joint occur. These tissues cannot be improved, but restoration of balanced occlusion usually removes the source of stress and damage, so that pain and trismus are relieved. Fortunately, this type constitutes the largest fraction of the cases. In a recent series by Sanders,[1] 66 out of 75 were tabulated as symptom-free one year after occlusal restorations. This is a common achievement of many observers at this time, most of the credit accruing to the dentist who has balanced the occlusion.

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This investigation was supported by the John S. Swift Fund and is being continued.

However, what is to be done about the remaining fraction who still have symptoms? To whom does the remaining 15 per cent belong? It is not enough for the patient to be balanced by a perfectly competent dentist to millimeter accuracy and, when not satisfied, to be sent by a friend to another competent operator to repeat the entire program. If possible, the following similar and simulated pain conditions must be recognized:

1. Trigeminal neuralgia, and atypical toxic neuritis (commonly sought and recognized).

2. Cerebral vascular disease (pain fluctuates with the stage of the disease).

3. Intracranial or extracranial tumors (parotid and condylar tumors, misleading when early).

4. Conversion neuroses (infrequent, but mimic all pain effects, demanding repeated changes in occlusion and consultants—hopeless prognosis).

5. Masseter tremor (obscure, when not accompanied by other muscle palsies—poor prognosis unless underlying emotional conflicts can be corrected).

Deducting the above uncommon reasons, after applying any indicated extraoral treatment, there still remains a number of cases in which structural changes perpetuate the symptoms. These are:

a. Destruction of the meniscus, cartilage
b. Bone erosion of the condyle, tubercle and fossa
c. Exostoses, usually of the condyles
d. Ankylosis, all stages, in addition to limitation of motion by trismus
e. Loosening, all stages of subluxation

TREATMENT BY INJECTION OF JOINTS

Schultz and Shriner[2,3] attacked the hitherto difficult problem of subluxation of temporomandibular joints by injection of a sclerosing substance, sodium psylliate (sylnasol) into both joints, obtaining satisfactory results in 200 cases. The injections were repeated every two or three weeks until painful clicking or grating subsided.

With the advent of cortisone, its first intra-articular use gave disappointing results, no cases being improved. Holland and coworkers[4] in 1951 made a comparative study of intra-articular injections of hydrocortisone into joints involved with active rheumatoid arthritis, making 178 treatments on 51 patients. Swelling, tender-

ness, and freedom of motion improved, disregarding pain records as unreliable. So great was the improvement that the study was expanded to 70 treatments on 129 patients, this time including osteoarthritis (degenerative joint disease), traumatic arthritis, gouty arthritis, and bursitis. The results were equally prompt and favorable. The beneficial effect of hydrocortisone was thus shown to be nonspecific because it was effective in a variety of inflammations from different causes. The action is still unknown but the work of Dixon and Bywaters[5] supports the assumption that the hydrocortisone suppresses the local reaction to irritants, stress, and trauma.

In the series of Hollander and others which followed, the injections were made into various movable joints, mainly knees, as well as into bursa. The first important use in the temporomandibular joint was reported by Pirkey[6] in 1955, reporting a series of 350 patients, treated over a two year period. Pain was absent for an average of five and one-half months, with only 14 of the series unimproved. It was significant to note that all patients whose bite was corrected remained symptom free.

During the past year all patients referred from various departments of the Washington University Clinics were conservatively screened, leaving out all cases of neuralgia not proved to be of mandibular joint origin. Of those with positive data, 20 patients received hydrocortisone injections into the temporomandibular joint. These are summarized, with pertinent physical findings and results, as follows:

REPORT OF CASES RECEIVING INJECTION OF HYDROCORTISONE INTO THE TEMPOROMANDIBULAR JOINT

CASE 1. F. C., a female, aged 51 years, examined on May 20, 1955, gave a history of chronic anxiety state and burning of the right side of the pharynx, tongue, and nose for two years.

Examination showed bilateral absence of the lower molar teeth. There was bilateral tenderness of mandibular joints to internal palpation. X-rays showed widening of the joint spaces.

On June 3, 1955, the right joint was injected with 25 mgm hydrocortisone. Burning of the right side of the tongue was reported much improved on July 8, 1955, with residual perioral prickling.

CASE 2. T. W., a female, aged 49 years, examined on June 3, 1955, had a history of untreated myoma of the uterus. She described an intensely painful otalgia on the right side, of two weeks' duration.

The right joint was very tender to palpation, and x-rays showed the right condyle 20 per cent larger than the left, properly spaced.

On June 3, 1955, the right joint received injection of 25 mgm hydrocortisone. On July 8, 1955, she reported that she was entirely relieved, after three days of facial stiffness.

CASE 3. G. P., a female, aged 42 years, examined on January 14, 1955, had multiple complaints, a chronic anxiety state, with a history of several abdominal operations. Dental overlays worn for nine months gave relief from bilateral otalgia and occipital headache, then all returned. The dental overlays were removed by Dr. T. L. Sanders on May 20, 1955.

Films of the joints showed condyles posteriorly displaced; excursion was normal. There was a fine tremor of the masseter muscles evident on palpation, of about three oscillations per second.

Hydrocortisone, 25 mgm, was injected into the left joint on June 10, 1955. The injection was followed by glossodynia on the left side which lasted one day. The symptoms of bilateral otalgia and occipital headache were still present on July 15, 1955.

CASE 4. E. C., a female, aged 64 years, examined on April 22, 1955, had numerous vague complaints, and few findings. She had had left-sided otalgia for several years.

Examination showed both joints tender to palpation; x-rays showed normal joint spacing and normal bone outlines.

Two weeks of elastic splinting of the lower jaw completely relieved the left-sided otalgia. The left joint was injected with 25 mgm hydrocortisone on May 6, 1955, and the patient was symptom free on May 20, 1955.

CASE 5. E. G., a female, aged 53 years, when examined November 30, 1955, complained of intense otalgia on the right side. This condition had existed since June 1954, aggravated when jaws "popped out of place."

X-rays showed decreased excursion of the condyles. Neurological examination on November 12, 1954, by Dr. Kempinsky was negative, except for bilateral trismus.

On November 30, 1954, she could not tolerate dentures and was not able to insert them into the mouth; elastic strap could not be worn. Hydrocortisone, 25 mgm, injected into the right joint on

April 15, 1955, gave her marked relief from pain and trismus. On June 3, 1955, she had only slight otalgia, which became worse during a rainy season or on chilling.

CASE 6. J. W., a female, aged 35 years, was seen on April 8, 1955. She gave a history of numerous abdominal and orthopedic problems. There was popping of the left mandibular joint, otalgia on the left side, occipital and vertex headache, and vertigo.

Examination revealed tenderness of both joints, shift of jaw to the left on opening, with increased otalgia. X-rays showed increased density in the left joint.

Elastic splinting of the jaw with a 2 mm cork disc within the right side completely relieved the left-sided otalgia. The left joint was injected with 25 mgm hydrocortisone on April 29, 1955, and has been much improved since.

CASE 7. A. McC., a female, aged 66 years, gave a history on April 15, 1955, of a "tic" of the jaws for years, domestic problems, severe conversion neurosis studied by Dr. Haddock.

Neurological review by Dr. Kempinsky on April 12, 1955, was negative, but showed tremor of the masseters and tongue.

Use of an elastic splint to the lower jaw began on April 15, 1955, followed by less "catching" of the jaws and less otalgia, left. About June 10, 1955, she began to have pains radiating to the left neck and shoulder, and could not raise her left arm. On that date 25 mgm of hydrocortisone was injected into left joint with much relief.

CASE 8. M. Q., a female, aged 43 years, gave a history of operation for ventral hernia in 1954, and for fistula in ano in 1953. For years she had had otalgia on the right side, and crackling of both jaw joints.

Tenderness of both joints was elicited on palpation.

On May 29, 1955, elastic splinting was begun, carrying a 2 mm cork within the left side, with immediate relief. Hydrocortisone, 25 mgm, was injected into the right joint on June 10, 1955, and complete relief was reported on July 8, 1955.

CASE 9. E. T., a female, aged 70 years, was seen on July 8, 1955. She described otalgia, pharyngeal pains and tinnitus on the right side of 18 years' duration.

Examination showed moderate nerve deafness. Both joints were tender to pressure and a bilateral masseter tremor was present. X-rays revealed squaring of the outline of the right condyle, and restriction of forward motion of the right condyle.

After one week of elastic splinting of the lower jaw she admitted no improvement, and on July 15, 1955, the right joint was injected with 25 mgm hydrocortisone. Aural pains on the right were said to have been only slightly relieved, and when she stated otalgia on left side was really worse, 25 mgm hydrocortisone was injected into the left joint on July 22, 1955. Later report of symptoms were not considered reliable.

CASE 10. J. D., a female, aged 72 years, was examined on June 20, 1955, giving a history of diabetes, obesity, and inability to open the jaws for three years.

Examination showed restriction of the jaw opening to one-half normal. X-rays revealed limited excursion of the right condyle, its anterior face being irregular and roughened.

On June 20, 1955, the right joint was injected with 25 mgm hydrocortisone and she reported on July 8, much relieved of pain. Because of restricted motion and peculiar notching condyle, external surgery of the joint was advised.

CASE 11. M. O., a female, aged 47 years, was examined on April 22, 1954. She described a left-sided facial pain which Dr. S. Maughs and Dr. J. O'Leary felt was not typical of trigeminal neuralgia.

When examined on April 22, 1954, the left mandibular joint was very tender to pressure. She found the elastic splint with a 2 mm cork between the molars on the right side very relaxing. On April 15, 1955, there was still crepitus in the left joint and she relied on the elastic splinting for comfort.

On April 15, 1955, 25 mgm of hydrocortisone was injected into the left joint. On May 25, 1955, she reported complete relief of all pain since the injection. Following the injection there was reddening of the left eye, and herpetic spots appeared over the root of the nose on the left side.

CASE 12. E. M., a female, aged 60 years, was examined on May 3, 1955. She described otalgia on the left side so severe that soft foods only could be taken, which had not been relieved by complete dental restoration the past year.

Examination showed tenderness of the left joint to palpation. X-rays showed narrowing of the joint spaces on the left, the condyle head irregular, with a diagnosis of arthritic change.

She was not improved by the use of elastic splinting of the jaw, which she used for two months; on July 20, 1955, 25 mgm hydrocortisone was injected into the left joint. She reported on August 16, 1955, completely free of pain.

CASE 13. M. McC., a male, aged 65 years, was examined on July 19, 1955. He gave a history of trigeminal root resection on the right side in 1928 and again in 1942, with right facial numbness. Since then he chews entirely on the left side. Intense otalgia began 18 months ago, radiating to the lower jaw and cheek, and increased by chewing. His dentures have been replaced three times.

Examination on July 19, 1955, showed occlusion perfectly balanced. The left joint was tender to palpation. X-rays showed normal joint structures.

On July 19, 1955, hydrocortisone, 25 mgm, was injected into the left joint, with no relief of any symptoms. He refused further treatment.

CASE 14. D. G., a female, aged 69 years, was examined on July 6, 1955. The history included only otalgia on the left side for two and one-half years, and glossodynia, left.

Examination showed no tenderness of the joints. X-rays revealed narrowing of the left joint spaces, the condyle head hypertrophic. X-ray diagnosis was arthritis.

She was treated by elastic fixation, which improved all attacks of pain; on July 15, 1955, 25 mgm hydrocortisone was injected into the left joint. She was not improved on July 29, 1955.

CASE 15. N. C., a female, aged 52 years, was examined on June 6, 1955. She reported otalgia, left, after dental extractions four years ago. She has had several changes of dentures. Some attacks of otalgia were so severe she could not chew until it subsided.

Examination showed both joints very tender to palpation, the jaws overclosed on inadequate dentures. X-rays showed normal bone outlines, the right condyle being displaced anteriorly.

Elastic splint to the jaws relieved the pain promptly. Hydrocortisone, 25 mgm, was injected into the left joint on June 6, 1955. Complete relief of pain was reported on August 9, 1955, and she was sent for new dentures.

CASE 16. K. G., a female, aged 60 years, was examined on March 21, 1955. She was hypertensive; there had been a diagnosis of diffuse arterial disease. There was constant intense otalgia on the left side, increased on chewing.

There was tenderness of both joints to palpation, and x-rays showed fixation of the right condyle with no change in bone outline. She had bilateral masseter tremor.

On March 21, 1955, the left joint was injected with 25 mgm hydrocortisone. She was much relieved when seen on April 10, 1955, but still had some pain. On May 20, 1955, the left joint was again injected with 25 mgm hydrocortisone. A left-sided temporal pain persists, but otalgia on chewing has been entirely relieved.

CASE 17. N. S., a female, aged 55 years, was examined on July 22, 1955. She complained of bilateral otalgia on jaw motion, not improved by balancing of occlusion two years before.

Tenderness of both mandibular joints was shown, but x-rays were entirely negative.

On July 22, 1955, the left joint was injected with 25 mgm hydrocortisone. She was much improved, and on September 9, 1955, the right joint was similarly injected.

CASE 18. R. R., a female, aged 36 years, was examined on July 14, 1955. She gave a history of otalgia on the left side, radiating to the lower jaw, of eight months' duration.

There was tenderness of both joints, and no upper molar teeth on the left side. X-rays showed only loosening of joint structures, bone outlines were normal.

She was greatly improved by elastic splinting of the jaws, separating the right side with 2 mm cork discs. On July 29, 1955, 25 mgm hydrocortisone was injected into the left joint. She was symptom free on September 9, 1955.

CASE 19. B. C., a male, aged 64 years, was examined on August 4, 1955. He had otalgia on the left side for one year, and was said to have osteo-arthritis of the spine.

X-rays showed loosening of the joints, but no arthritic change.

On August 4, 1955, 25 mgm hydrocortisone was injected into the left joint with complete relief of otalgia. The remaining occipital pain was attributed to arthritis of the cervical spine.

CASE 20. W. W., a female, aged 30 years, was examined on September 1, 1955. She described otalgia on the left, radiating to the occiput.

Bilateral tenderness of the joints was the only positive finding.

On September 9, 1955, hydrocortisone, 25 mgm, was injected into the left joint with much improvement of the left-sided otalgia reported, two weeks later.

All cases treated by hydrocortisone injection reported partial or complete relief of pain, except Case 13, who is presumably developing trigeminal neuralgia on the left, after trigeminal root resection on the right side. The duration of relief from pain is not too significant in this group because the longest period since treatment is actually about six months. Glossodynia was relieved in Case 1 by the injection and was produced in Case 3 by it, the tongue pain lasting one day. The result was indeterminate in Case 4. One can assume that these were direct effects upon joint branches of the auriculotemporal nerve and the chorda tympani nerve reflexly or directly effecting sensations of pain in the tongue. Ten cases of glossodynia were reported from this Clinic in 1935,[7] and numerous similar ones tabulated in two large series since that date. One case receiving hydrocortisone without remarkable benefit had masseter tremor, further discussion of which follows.

BILATERAL MASSETER TREMOR

A segment of cases with uniformly poor results from all types of treatment present the common symptom of masseter tremor. Thirty were observed during the past year. (Twenty-two of these comprise a recent report[8] on masseter tremor, as an important basis of mandibular joint dysfunction.) There was no problem of occlusion or the occlusion had been restored. Yet otalgia, radiating facial pains, tiring of jaw muscles, as well as local tenderness of mandibular joints, were present, unchanged after treatment of any kind. Questionable relief followed injection of hydrocortisone in three persons and one insisted that the pain complex was increased by the injection. This one exception to the usual experience with intra-articular injection of hydrocortisone raised the question of reliability. At this point the observation of masseter tremor was observed during casual palpation of the jaws. The cases were studied in the Neurology Clinic by Drs. O'Leary and Kempinsky[9] who found none of the stigmata of general palsies or of senile tremor. They agreed that this muscle tremor originates on a functional or psychogenic basis, initiated at the subsconscious level. The pathogenesis is not clear, neurological

examination being negative. Since emotional overlay is a large factor in this condition, psychotherapy appears to hold promise in treatment. Meanwhile, in spite of the failure of treatments directed to jaw structures the patients, without exception, are relieved by passive support, simple elastic splinting of the jaw and masseter muscle group. Short half-hour periods are more effective and more restful than longer ones. A few have shown improvement on reserpine medication, conclusions on which are reserved for more extensive observation.

SURGICAL TREATMENT

Surgical treatment of the temporomandibular joint is directed mainly to relief of painful crepitus, or to ankylosis of the joint. For irreducible luxations Dufourmentel[10] in 1921 concluded that extirpation of the meniscus was the most effective procedure. Alcohol injections into the masseter muscle had been used by Sicard with same success, and it was obvious that looseness of the anterior part of the capsular ligament was not as important as the deformed disc, which prevents the condyle from returning to its normal position in the glenoid fossa.

Numerous cases of temporomaxillary surgery were reported during the period of 1890 to 1930. The classic monograph of Dufourmentel[10] in 1929 reviewed all types of cases, myotonic trismus, arthritis, painful crepitus, fractures, and ankylosis. He described all earlier techniques and his own. Studies and surgical treatment by Kontjetzny[11] in 1921 had identified habitual subluxation, degenerative changes of the meniscus, and painful crepitus as a cycle; and that painful snapping or crepitus is the middle point between luxation and discus changes. Axhausen[12] in 1931 made prolific studies of these changes, devised graphic records of the crepitus phenomenon, classified luxations as meniscotemporal or meniscocondylar, crepitus as intermediate and terminal, and produced microscopic studies of all stages of disc pathology in ten cases. Dufourmental and Axhausen employed the postoperative use of spring-elastic devices after meniscus excision to overcome long-standing muscle contracture and to obtain normal mouth opening.

A variety of incisions anterior to the auricle were used by numerous authors to expose the joint, each devised to avoid injury to the superior branches of the facial nerve. At that point Axhausen improved the incision of Bockenheimer, which is a postauricular incision, transecting the external ear canal and elevating the upper part of the parotid gland to obtain complete exposure of the joint.

Norgaard[13] in 1947 reported 113 cases studied by injection of contrast medium into the temporomandibular joint, correlating roent-

genographic with operative findings in 25 cases. The operative group were done by Husted, by the method of Bockenheimer-Axhausen, 20 of which had resection of the meniscus, and 5 amputation of the condyle. In recent correspondence with Dr. Husted[14] he stated that his series is now 150 operative cases, one-half with arthrosis, treated with meniscectomy, the remaining half ankylosis, treated by condylectomy. Dr. Husted's series constitutes the largest group of cases treated by temporomaxillary surgery since the series of Blair[15] in 1914, which applied to 212 cases of ankylosis. Rongetti[16] reported 3 cases of meniscectomy recently, describing the use of endaural incision. This certainly simplifies approach to the joint and minimizes the chance of stricture of the external ear canal. The endaural incision was used in each of the 5 cases reviewed in the following cases:

REPORT OF CASES OF SURGICAL TREATMENT OF THE TEMPOROMANDIBULAR JOINT

CASE 1. M. S., a female, aged 36 years, was examined on November 30, 1954. She described sharp jabs of pain into the left ear on chewing or moving the lower jaw since September 1, 1954.

X-rays showed roughened areas on the surface of the left condyle. There was tenderness of the left joint to palpation and limited motion of the lower jaw.

The use of elastic jaw support gave little relief and a course of B_{12} injections was followed by no improvement. On February 8, 1955, endaural meniscectomy was done on the left side. The meniscus was thin, with very few adhesions. Two sharp edged exostoses on the lateral border of the condyle were removed by burr. She had complete relief and excursion of the lower jaw was wider when she was checked on June 7, 1955.

CASE 2. N. B., a female, aged 32 years, was examined on August 31, 1953. She gave a history of bullet injury to the left joint 10 years ago followed by complete ankylosis of the jaw. There was intense otalgia, left, on forced movement of the jaw.

X-ray showed an oval defect in the cortex above the left zygoma (postoperative) and the joint outlines were obliterated. The joint area carried several metallic spots.

On August 3, 1955, the bony mass beneath the left zygoma and the head of the condyle was removed via endaural incision. Opening of the jaw was increased to 1 cm. Healing was delayed, with constant leakage of cerebrospinal fluid from the external canal. She was still being dressed on September 1, 1955.

CASE 3. C. L., a female, aged 49 years, was examined on October 28, 1954. She gave a history of general rheumatoid arthritis treated at Barnes Hospital in 1952, and was much improved on myocrysin, 12½ mgm per week. Trismus began at the time of a sore throat in 1954.

Examination showed a 50 per cent trismus, which was improved at first on elastic splinting. After two months she had extreme otalgia on the left side on jaw movement.

On March 5, 1955, endaural arthroplasty was done, revealing the disc and joint space replaced by fibrous tissue. The mass was removed and the uneven surface of the condyle was polished with the burr. She was much improved on April 22, 1955, free of pain, the jaw opening almost to normal.

CASE 4. R. G., a female, aged 53 years, was examined on April 22, 1955. She gave the history of carcinoma of left tonsil, treated in 1953 with radon seeds. She had had very bad occlusion since a broken right jaw in 1949. One year ago, a neck dissection was performed with section of the left glossopharyngeal and superior laryngeal nerves. This was done for intractable pain in the left jaw.

On April 22, 1955, she had constant otalgia on the left side and tenderness of the left joint. X-rays showed fixation of the right condyle, the head of the right condyle being enlarged and bilobular.

Arthroplasty was done on the right side, endaurally, on May 21, 1955. The meniscus was fibrous and webbed to the capsule by adhesions. It was removed and exostoses on the condyle smoothed by burr. Drug addiction was confirmed on May 27, 1955, making reports on comfort unreliable. The external ear canal healed slowly, but healing was complete by July 1, 1955. All pains and trismus apparently improved by July 29, 1955.

CASE 5. M. K., a female, aged 51 years, was examined on February 9, 1955. She gave a history of soreness of the right lower jaw for one and one-half years. Three months before this date, the right lower third molar had been removed. This was followed by trismus and intense otalgia, right, on any movement of the jaw.

Opening of the mouth was limited to 1 cm and the movement was attended with right sided otalgia. Elastic fixation of the jaw gave relief. X-rays showed no excursion of the right condyle on opening.

On June 9, 1955, endaural arthroplasty was done on the right joint, removing the meniscus and scar tissue. A portion of the tym-

panic plate 1 cm x ½ cm was movable, as if from fracture, and was removed. Complete relief of all pain was obtained, and the jaw opening had increased to 3 cm, when seen on July 23, 1955. She was started on Seaver's myotonic exercises.

COMMENT

Temporomandibular joint problems fall into three general categories, those in which occlusal restoration permanently relieves pain symptoms, those responding to direct treatment of the joint and those whose symptoms simulate origins about the joint, for which no treatment of any kind is indicated.

It is axiomatic that occlusal restoration should be achieved before or after all efforts directed to the joint itself.

The newest treatment to be used in joints of the body, weight bearing, fixed or movable, is intra-articular injection of hydrocortisone. Its use in the temporomandibular joint is feasible during or after dental reconstruction, with excellent results. It is of great practical value, and although still classified as a palliative measure, no adverse reactions have been noted in any case.

Contraction of masticator muscles occurs during years of abnormal jaw action. After surgery on the temporomandibular joint, reeducation of the masticator muscle group may be done by

1. Voluntary myotonic exercises (Seaver),
2. External elastic splinting to produce leverage within the jaws, or
3. Intra-oral spring applications for forcible opening of the jaw

The number of cases of masseter tremor is relatively small, as compared to the enormous group of mandibular joint neuralgias successfully treated. However, as one would expect, no restoration of occlusion has been of value in any case where masseter tremor is present. If masseter tremor is observed, the prognosis after any treatment of joint or jaw position is unequivocally poor.

3720 WASHINGTON BLVD.

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V

PLANES OF SURGICAL DISSECTION OF THE NECK

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Surgical dissection of the neck must necessarily be based on an intimate knowledge of the anatomy. There are, however, so many varied descriptions of the structure of the neck which employ such a profusion of confusing terms, that it is sometimes difficult to follow such detailed descriptions. This is particularly true in regard to discussions of the fascial layers.

As long ago as 1838, the French anatomist, Malgaigne, very pointedly stated, "The cervical fasciae appear in a new form under the pen of each author who attempts to describe them." This holds so well even today—112 years later.

More recently, Weintraub rephrased this thought in saying, "The statement of the precise site and precise manner of the union of the three layers of the deep cervical fascia is an expression of the individuality of the author; it is different in each text."

It is not our purpose to discuss in detail the many descriptions and variations of the cervical fascia nor to compare the descriptions of one author with those of another. Many have made invaluable contributions to the knowledge of the anatomy of this region. However, surgeons are confronted daily by problems relating to surgery of the neck and the solution to many of these is dependent on study of the anatomy of the neck and the planes of surgical dissection.

Let us review briefly the classical, generally accepted description of the fascial planes of the neck with which most surgeons are familiar. With such a classical description as a foundation, a less detailed concept of these connective tissues can be presented—one which seems to be of greater practical significance particularly to the surgeon faced with the specific task of operating in the neck.

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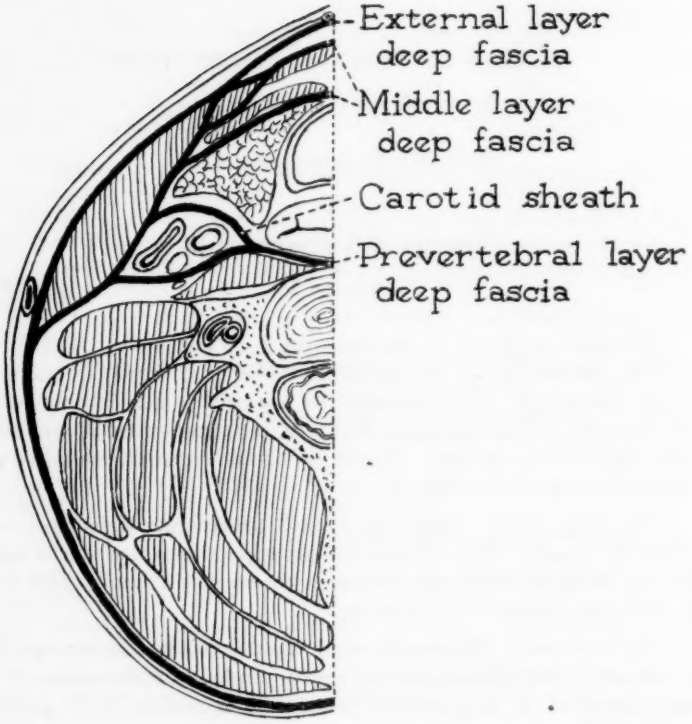

Fig. 1.—Cross section of neck showing diagrammatic representation of the three fascial layers as generally accepted. Our dissections on cadavers and at surgery have at no time revealed such a structural arrangement.

The cervical fascia consists of two chief layers—superficial and deep (Fig. 1). The superficial fascia consists of fatty tissue and includes the platysma muscle within it. The deep layer was first described as consisting of three layers by Tillaux in 1882 and it was he who introduced the term "middle" for the omohyoid layer and its derivatives. The deep cervical fascia is made up of an outer layer or superficial layer; a middle layer—or omohyoid layer and a deep layer. The outer layer is said to envelope the entire neck, passing forward from the surface of the trapezius muscle fusing to form a roof over the posterior triangle, splitting again to envelope the sternocleidomastoid muscle and then fusing again anterior to this muscle to pass across the midline to the opposite side. In the upper neck

it is attached to the hyoid bone, then sweeps upward to split and envelop both the parotid and submaxillary glands in separate compartments finally attaching to the mandible anteriorly and the zygoma above the parotid. Descriptions of this fascial layer, particularly in relation to the parotid, are especially variable. Some say it passes only to the deep surface of the gland, or that it splits about it but is particularly thin and deficient on the deep surface, and so on.

Descriptions of the middle layer of the deep fascia are even more variable. This layer includes the fascia about the strap muscles which are in several layers, as well as the visceral fascia including the buccopharyngeal fascia about pharyngeal constrictors and the pretracheal fascia lower in the neck intimately associated with the thyroid gland fascia. So that here we have a description of the fascial layer which is hardly a single layer of firm fascial tissue but rather is made up of many parts in different regions of the neck.

The deep layer of deep cervical fascia is generally described as the prevertebral layer. It lies immediately over the bodies of the cervical vertebrae and prevertebral muscles and extends laterally to the transverse processes of the cervical vertebrae.

In addition, in most standard anatomy texts, a firm sheet-like carotid sheath is described as completely enveloping the neurovascular bundle containing the carotid artery, internal jugular vein and vagus nerve. Several anatomists have denied the existence of a true sheath around the carotid vessels. Others have described the sheath as incomplete medially. Mosher, in his classical article in 1929[1] describing the submaxillary fossa approach to pus deep in the neck, considered the carotid sheath the main fascia from which the other cervical fascia stemmed or took origin. Still other anatomists have attempted to demonstrate histologically that there is no "carotid sheath" and that the fascial layers usualy described are for the most part artefacts.

Is there, then, any simpler concept of these connective tissues which will give the surgeon a better understanding of the anatomy of the neck and permit him to work with greater safety among the vital structures? Are there certain planes of dissection which will facilitate obtaining wide exposure and clear visualization of the structures of the neck?

In 1941, Weintraub[3] presented a description of a "new anatomic and functional systematization of the connective tissues of the neck." He considered all of these connective tissues in three large classes rather than individual, minutely subdivided fascial sections. These included:

Fig. 2.—Single layer of gauze shown to represent the effect of tension on the loose areolar tissue of the neck. Without tension (left), it has a loose, cobweb appearance. Under tension (right), there is condensation of the fibers into a compact, dense layer suggestive of fascia.

1) Nerve—vessel supporting connective tissue,
   a) Nerve—vessel bundles about main trunks and
   b) Nerve—vessel sheets about branches of vessels and nerves.
2) Periorgan connective tissue, including the condensation of the loose areolar tissue about individual organs in the neck.
3) Areolar tissue spaces, consisting of loose areolar "packing" tissue filling the spaces between the muscles, vessels and organs in the neck.

Dissection of the neck in the fresh cadaver and in the living patient reveals the above to be the arrangement of the connective tissues of the neck.

Embryologically, all of the neck structures except the epithelium and nervous tissue develop from the primitive mesodermal mesenchymal tissue. As the muscles, vessels and other organs of the neck develop, they differentiate in a bed of unchanged loose areolar tissue which persists in the adult, filling all the potential space between these organs. Mechanically, it is the persistence of this loose, cobweb-like filling areolar tissue which permits movements of the organs and tissues one upon the other. In the neck particularly, where freedom of

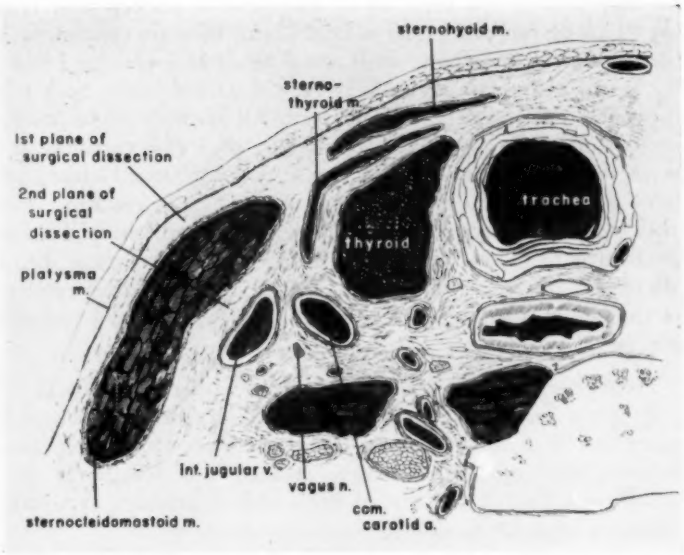

Fig. 3.—The loose connective tissue fills the potential spaces between the parenchymatous structures. Where this tissue is attached to the latter structures, it is condensed to form a perimysium, perineurium, periosteum, etc. The normal movement of organ upon organ is permitted by the shearing action of this loose areolar connective tissue. The first plane of surgical dissection which is directly below the platysma muscle facilitates the skin flap formation which is essential for adequate exposure.

movement is especially necessary, this tissue is abundantly distributed. It might even be considered the lubricating system of the moving parts of the neck permitting smooth gliding movements of the neck structures. However, with these movements there are shearing forces and these produce condensations of the loose areolar tissue into denser layers, particularly on the surface of the moving organs and forming the periorgan connective tissue mentioned earlier. On the surface of the muscles are condensations forming a perimysium and their fascial layers. On the vessels are condensed peri-adventitial layers (Fig. 2).

Surgically, this filling of loose areolar tissue whose mechanical function has been described, presents preformed planes which may be followed by careful dissection both in the anatomical laboratory and in the operating room. Dissection in the neck along these planes wherever possible permits wide exposure with a minimum amount

of trauma and maximum safety. Haphazard dissection in this same tissue may lead to the creation of innumerable pockets and fascial layers which do not truly exist as layers until they are created during the course of the dissection. It is not difficult to understand how so many fascial planes and layers have been described in the neck when one sees how easily they can be created. All of this may be observed to occur during the dissection and freeing of a cyst surrounded by loose areolar tissue when the artificially "manufactured" layer after layer is produced until the true wall of the cyst is reached. None of these so-called "layers" are found when careful, sharp dissection perpendicular to the cyst wall cuts through the areolar tissue directly to the wall. Sharp dissection in the areolar tissue planes results in retraction of this soft tissue with clear exposure of the embedded vessels, nerves and organs.

The first plane of surgical dissection is relatively superficial (Fig. 3). It is the one which lies between the platysma muscle and the condensation of tissue making up the outer layer of the deep fascia. Before this layer of areolar tissue is reached it is difficult to obtain adequate retraction of the wound edges and satisfactory exposure of the field.

There are other regions of the body where wide exposure is necessary for surgical manipulation, but nowhere is clear, wide exposure of greater importance to the surgeon in the safety of the patient than among the closely placed vital structures in the neck. Adequate incisions into the plane of dissection beneath the platysma will expose necessary landmarks to permit deeper exploration of the neck. Without these, orientation becomes much more difficult and, at times, impossible, in a region where the surgeon must remain well oriented as he progresses layer by layer to the pathology situated in the deeper parts of the neck. Exploitation of this loose layer by sharp dissection permits creation of good skin flaps with a minimum of bleeding and thus permits wide exposure of the deeper operative field. The platysma muscle is such a large broad band extending from the clavicle to the mandible that almost all incisions in the neck are developed through it and the surgeon should make use of the areolar tissue below it in his dissection. During construction of the skin flaps the loose areolar tissue may be clearly seen by maintaining constant, gentle upward traction on the flaps as the dissection progresses. Large superficial veins may be exposed and avoided; or if necessary, clamped, cut and ligated.

The second plane of dissection is among the deeper structures of the neck below the outer layer of deep fascia. There is no specific fascial plane and no apparent distinct layer of fascia enveloping all

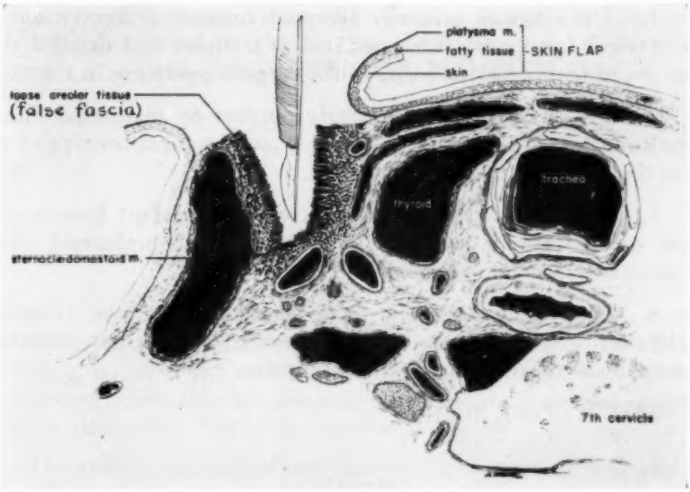

Fig. 4.—Transection of the loose areolar tissue of the second plane permits spontaneous retraction and condensation, which is misinterpreted as a deep fascia. Gentle traction of this collapsed tissue will bring to light its true loose nature.

of these structures. However, the loose areolar tissue may be found filling all of the spaces between the muscle layers and surrounding all of the organs. Dissection through this loose areolar tissue perpendicular to important structures results in retraction by the elastic fibers and clear exposure of organs to be preserved (Fig. 4).

This deeper plane may be found in all regions of the neck, in the submaxillary and submental regions above; in the parotid and sternomastoid regions laterally; in the posterior triangle laterally and posteriorly, and in the visceral region anteriorly. It does not actually exist as a single plane but is developed in several deep planes varying with the extent of the surgical procedure and the region of the neck explored. In the submaxillary region, for example, this deeper plane will be found in the areolar tissue about the submaxillary gland and overlying the digastric and stylohyoid muscles. In the course of a laryngectomy, several deep planes may be utilized in the loose areolar tissue beneath the sternohyoid muscles, beneath the sternothyroid muscles and about the thyroid gland. When this type of dissection is carried out, the deep structures may safely be exposed layer by layer with constant maintenance of necessary landmarks.

CONCLUSIONS

1. The classical, generally accepted anatomical descriptions of the cervical fascia are often presented so complex and detailed that they are of little practical value to the surgeon operating in the neck.

2. On the basis of an adequate number of anatomical dissections and operative procedures, a simple and practical concept of the dissection of these tissues is presented.

3. Emphasis is placed especially on the abundant loose areolar tissue which acts as a "packing" tissue and presents preformed planes of dissection for the surgeon.

4. Careful dissection in these planes permits safe, thorough exploration of the neck with wide exposure of important structures and clear visualization of the entire operative field.

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VI

CHRONIC OTITIS IN CHILDREN

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To write in 1955 a paper on chronic otitis in children is nearly the same as creating a new chapter in otology. At least it requires the filling up of a gap on the classical textbooks which are so well documented where they are concerned with chronic auricular suppuration in adults.

The symptomatological and therapeutic aspects so well known in adults cannot simply be applied to children; there are important differences. Certain clinical forms of chronic otitis, particularly when seen in older children, are like those encountered in adults, although the severity is indubitably less. In young children, however, it is impossible not to isolate a clinical aspect characteristic of this age, of which the etiological, clinical and therapeutic aspects are clearly distinct. This form, which we refer to as "atticotympanic mucopurulent otorrhea" is not seen in adults and seldom in older children.

Chronic otitis should not be left unheeded in infants; it is curable in many cases, and well conducted treatment will make it possible to avoid the constant risk entailed: definitive hardness of hearing.

Distinction may be made between five etiological clinical and therapeutic forms of chronic otitis in children, viz.:

1. Mucous, so-called tubal otorrhea, in which the non-marginal perforation is localized in the inferior quadrants of the pars tensa.

2. Atticotympanic mucopurulent otorrhea, in which the non-marginal perforation is localized in the paracentral region or in the posterosuperior quadrant.

3. Antroatticotympanic suppuration, in which the marginal perforation is localized high in the subligamental part.

4. Suppuration of the attic, in which case the perforation is localized at the level of Shrapnell's membrane.

5. The fundus tympani with subtotal destruction of pars tensa.

This classification is of necessity an arbitrary one and there are transitional forms; yet it would seem to be the most satisfactory basis on which to manage the treatment of chronic otitis in children.

1. *Mucous, so-called tubal otorrhea, in which the non-marginal perforation is localized in the inferior quadrants of pars tensa.*

This may be observed in all age groups; its frequency is the same in the two-year group as in the ten-year group.

An acute suppurative otitis is healed. The discharge has dried up, but the perforation has not closed. It persists in the inferior part of the tympanic membrane as a nonmarginal ellipsoid perforation with a clear-cut outline. This large opening makes it possible to see a more or less large part of the fundus tympani which may be wet or dried up.

Failure of the perforation to close may be due to an unsatisfactory general condition, the virulence of infection, the duration of the acute suppuration and especially to the lack of paracentesis or otological supervision, often associated with badly directed and more or less intensive antibiotic treatment. However this may be, if the tympanic membrane remains open, the ear is bound to start running again. This may be due either to reinfection or irritation by the external way (bathing, instillation of drops into the meatus) or during a cold, rhinopharyngitis or infectious or allergic coryza.

The discharge is a mucopus which may be ropy or clearly serous, often copious, not causing pain and not associated with fever (if there is pyrexia, it is attributable to the rhinopharyngeal condition). Once it occurs, it lasts throughout the winter, to stop only when summer comes.

The perforation would seem to show a tendency to progressive forward displacement; it may finish up by occupying the antero-inferior quadrant or it may enlarge to become a large reniform perforation of the entire lower half of the drum. The most important feature is that it invariably remains separated from the contours of the tympanic sulcus by a strip of tympanic membrane, although it may be difficult to see it before and below. The fundus tympani shows no epidermization but remains covered with normal mucosa, wet but not granulating. Secretions gather in the hypotympanic recess and the Valsalva maneuver gives rise to an afflux of mucous matter.

This otorrhea does not bring about any complication. Its severity is mainly functional. The classical denomination "tubal otorrhea"

is too restrictive. Not only the tubal, but also the nasal, rhinopharyngeal, tympanic and mastoid mucosa is secreting. The discharge is the sum of these secretions.

Treatment should therefore be concerned with:

a) The nose and nasopharynx: according to individual indication, adenoidectomy, aerosols, sinus irrigation by displacement, tubal massage, roentgentherapy of the rhinopharynx or radium applications.

b) The ear: irrigations with Hartmann's cannula followed by insufflations with a Siegle speculum of antibiotics with addition of hyaluronidase, or benzododecinium.

Products to be used should be selected on the basis of an antibiogram; neomycin and chloramphenicol seem to be the most efficient nowadays. Once the discharge has been reduced to simple dampness, treatment may be completed by insufflation of boric acid or antibiotic powder.

In the case of allergic otorrhea (suspected on account of the occurrence of a copious, clear serous sterile discharge containing eosinophiles and coinciding with allergic nasal sinusitis, edema or white lilac discoloration of the nasal mucosa with low retractility) antiallergic treatment should be associated with instillation of cortisone or antihistamines.

c) General treatment: iodine, arsenic, calcium, peptone vitamins A, C, D, thermal waters and climatotherapy if possible.

Yet in certain cases where the discharge is considerable, atticotomy should be attempted, especially in bilateral forms. Results are not misleading.

There remains the problem of closing the perforation. Prophyllactically, at the end of an acute otitis, attempts should be made to ensure closure by touching the edges of the perforation with trichloracetic acid and collodion. That may be difficult if the child is restless so that immobility cannot be ensured. Yet the touching of the fundus tympani and the provoked recurrence of the discharge may be wholesome in that resumption of spontaneous cicatrization is favored.

Later, closure of the perforation should not be attempted unless and until the rhinopharyngeal mucosa is dry and the otorrhea has been stopped long enough to make a relapse unlikely. If attempted too early, closure often provokes recurrence of the discharge. An artificial drum (crystal paper), such as is used successfully in adults

is hardly ever tolerated in children under the age of 10 to 12. Since, however, it is necessary to replace it from time to time, skin-grafting would seem to be preferable at this age.

Chronic serous otitis is an effusion in the tympanic cavity behind the intact tympanic membrane. It is associated only with mild pain and is manifested mainly by hypacusia and a sensation of fullness in the ear. It is therefore often not noticed until late, in children. Otoscopy reveals a liquid level or an opaque and slightly bulging tympanic membrane. The treatment is paracentesis followed by tubal insufflation.

2. *Atticotympanic mucopurulent otorrhea, in which the non-marginal perforation is localized in the paracentral region or in the posterosuperior quadrant.*

This affection, often bilateral, is seen particularly in children between one and five years of age. In older children, it is uncommon.

It differs from other clinical forms in that it is not at all identical with similar affections in adults. It is predominantly encountered in the lower classes, a fact which explains why so many otologists not attached to hospitals fail to recognize it.

One or several incompletely cured catarrhal or suppurative tubo-tympanic infections may leave the attic mucosa hyperplastic and polypoid. The small size of the various recesses in the epitympanic cavity makes easy obstruction of the openings between these various recesses and between the epitympanic and tympanic cavities, as soon as an inflammatory swelling of the mucosa occurs which, at this age, is normally thicker than it is in adult life. Often the indiscriminate use of antibiotics enables the general practitioner to assume, without any paracentesis or otoscopic control, that a mastoiditis, which should have been operated on, is cured. Fever and pain disappear; discharge subsides and may disappear completely after some time, to recur in a torpid manner without any unmistakable symptoms.

This mucopurulent discharge shows periodic variations in its copiousness. Sometimes it is so slight as to remain unnoticed. In no case has the discharge been of the thickness and fetor of that seen in adults. Otoscopy shows a tympanic membrane flat in front but bulging in the rear. The features are more or less inflammatory, with a perforation localized in the posterosuperior quadrant, juxta-umbilical or definitely posterior, but in no case marginal. It is always small, punctiform, with a thickened infiltrated edge, and easily overlooked. It is often necessary to use a Siegle speculum. The bulging sometimes forms a true "cow's udder," giving rise in some cases to a hernia of the

mucosa or to a true polyp. Incisions made in order to enlarge the usual punctiform orifice close rapidly.

The perforation closes if the ear does not run, but a complete return to normal of the tympanic appearance is rare. The handle of the malleus and its external process are hardly visible. There remains an infiltration of the posterosuperior quadrant, which remains opaque and congested. The impression is gained that the mucosa behind the tympanic membrane is hyperplastic and separated from the atrium. Hearing is diminished. Subsequently, spontaneously or after a new episode of rhinopharyngitis reactivating the latent infectious focus, the bulging increases, perforates and the discharge becomes highly resistant again to any local or general treatment.

If the child has been submitted to antrotomy or mastoidectomy, there occurs from time to time an abscess under the scar, classically attributed to recurrence of the mastoiditis and requiring an immediate reoperation in order to incise the abscess and to curette the mastoid again. Such children move from hospital to hospital and the preceding surgeon is, as a rule, accused of having neglected certain cellular groups. This remains so until the day on which they return to the otologist who has previously operated on them, often several times. In fact the term "recurrent mastoiditis," however well accepted, is a mistake. There is no mastoid osteitis. These relapses originate from hyperplasia of the epitympanic mucosa, which jams the communication between the tympanic and mastoid cavities. Persistent latent infection of the attic impedes the filling up of the mastoid cavity after the first operation. A flare-up of this epitympanic inflammation causes pus to collect at once in the tympanic and the mastoid cavities. If the measures taken do not go beyond management of the scar abscess by paracentesis and retro-auricular incision with or without curettage, then the "recurrent mastoiditis" will reappear sooner or later, sometimes several times a year.

Evolution may cover a period of several years, with remissions during summers and flare-ups during winters. A cholesteatoma may occur (10 per cent of cases). Some are even complicated by meningitis. It is often difficult, when a child is seen for the first time, to determine whether he is suffering from chronic otitis with attacks of "pseudoacute otitis" or whether the case involves a series of independent attacks of true acute otitis.

At the age of 7 to 8, two possibilities should be taken into account. The atticotympanic mucosa may lose its infantile and inflammatory characteristics to become less swollen and atrophic. Healing may be seen, but there are lasting sequelae such as perfora-

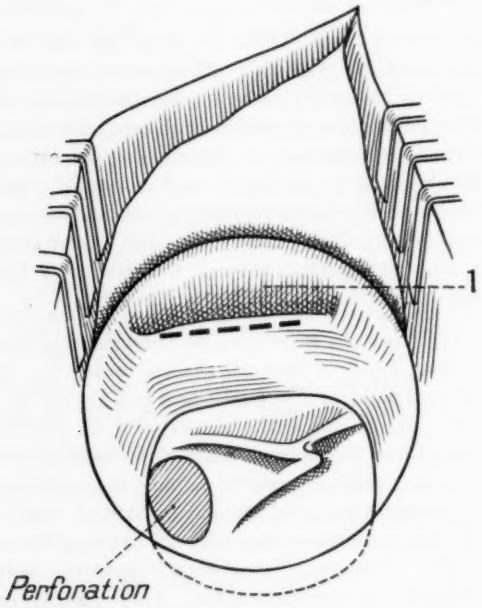

Fig. 1.

Fig. 2.

tion of the drum, adhesions, sclerosis and especially a considerable loss of hearing. On the other hand, inflammation at first limited to the mucosa may affect the adjacent bone, i.e., the incus, the head of the malleus and the threshold of the aditus. The latter is the site of predilection of swellings, polyps and granulomas. An extending osteitis of this type provokes destruction of the tympanic membrane facing it: the perforation, hitherto paracentral becomes a marginal one. In this manner the following form may arise, which is like the antro-attico-tympanic suppurations seen in adults.

These considerations regarding the pathogenesis explain the therapeutic indications.

Preventive treatment consists in intensive and proper care of all cases of acute otitis. The children should not be lost sight of until the tympanic membrane has returned to complete normality. Mastoiditis should be given surgical treatment without exaggerated continuation of antibiotic treatment, which does not offer any certainty as to complete and quick cleansing. When an operation is performed for anthritis or mastoiditis, it should be extended farther forward if the suppuration is older and the aditus should be opened until the short process of the incus is seen. The usual mistake, especially in case of antrotomy in infants, is that opening of the antrum is regarded as sufficient even if the otitis is of several months' standing.

In case of chronic otitis, local and general medical treatment and adenoidectomy are usually ineffective in this type. It is only natural that these attempts be made, but in case of failure or relapse, they should not be continued and no mastoidectomy should be resorted to either. The chief factor of chronicity lies in the attic and this can only be suppressed by a surgical intervention, whatever the age. It is said by most otologists that children must not be operated on before they are seven years old. That is true for radical mastoidectomy, but not for atticotomy, which is what we put forward. Why should we let an ear run for years if we can dry it up sooner by means of an easy nonmutilating operation?

Even in young children this is performed by the endaural route. It should not go beyond the stage of atticotomy, removing the external wall of the epitympanic cavity but preserving the ossicles. It should not be concerned with the mastoid cavity unless the case involves a mastoid cholesteatoma. The same holds true for scar abscesses. Curettage of the mastoid cavity is useless. It suffices to make a simple retroauricular incision in order to drain off the pus and to perform an atticotomy by the endaural route (Figs. 1 and 2).

3. *Antro-attico-tympanic suppuration, in which the marginal suppuration is localized high in the subligamental part.*

This affection is the same as that seen in adults. It is observed mainly in older children, above the age of seven to eight, yet it is not unusual in children four or five years old.

The perforation lies in the pars tensa, high in the subligamentous part, invariably posterior with the exception of a few rare cases where it is anterior. The perforation is always marginal. It resembles a fistula rather than a perforation and it is difficult to circumscribe its lower border, which is concave upwards and sticks to the fundus. It is covered with polyps and granulomas. There is moderate otorrhea, which shows nothing particularly typical of childhood cases.

It may be the result of the preceding form, with secondary osteitis of the ossicles and the threshold of the aditus. On the other hand it may have existed from the first, in which case its onset has been insidious, without any fever or pain; the attention is, as a rule, first drawn to the condition by a blood-tinged effusion or a foul smell.

The primarily chronic forms, the etiology of which has been open to considerable discussion, would seem to be due to the same process as the secondary ones, viz.: persistence of mucosal hyperplasia at the level of the internal attic and the atticotympanic pass. These forms do not come out till the stage of polypi and osteitis with or without cholesteatoma has been reached. Cholesteatoma is attributable to inflammatory metaplasia of the mucosa. In this confined situation, the desquamated cells gather to form a mass which slowly increases until it bores through the tympanic membrane. On the whole, cholesteatoma is primary by its correlation with manifest chronic otitis and perforation, but it is secondary to a succession of catarrhal inflammations occurring early in infancy. This is "cholesteatosis," in contrast to "true cholesteatoma," an embryonic tumor rarely seen which is the true primitive cholesteatoma.

If a cholesteatoma is discovered or suspected (28 per cent of cases) on examination, antro-atticotomy is performed by the endaural route, with removal of the incus and head of the malleus.

If no cholesteatoma is discovered, removal of the polypi is first resorted to; granulations are cauterized with chromic acid and an attempt is made at irrigations with the Hartmann's cannula. These local measures are associated with general treatment. Intramuscular injections of gold salts sometimes yield good results in these cases and should always be tried before surgical treatment is resorted to. The type of intervention will be selected according to the audiogram and

Fig. 3.

the extent of lesions discovered after opening the attic: atticotomy if hearing loss is less than 40 db, antroatticotomy with removal of the incus and head of the malleus if hearing loss exceeds 40 db or if there is a cholesteatoma in the attic, aditus and antrum.

4. *Suppuration of the attic in which the perforation is localized at the level of Shrappnell's membrane.*

This form is also analogous to conditions encountered in adults; it is the least frequently seen in children, in whom it is hardly encountered before the age of seven or eight years; one case has yet been observed at four.

In at least 50 per cent of the cases in children, perforations of Shrapnell's membrane either premallear or retromallear indicate cholesteatoma.

This form has a serious prognosis although it causes no great auditory harm. It requires antroatticotomy with removal of the incus and head of the malleus.

Typical of this age is the isolated polyp implanted on the neck of the malleus (Fig. 3) accompanied by otorragia. Simple removal of this polyp may suffice to ensure recovery without relapse.

5. *Fundus tympani with subtotal destruction of pars tensa.*

This form may be encountered at any age throughout childhood.

The perforation is extremely large, destroying nearly the entire pars tensa. This extensive reniform loss of tympanic membrane is usually surrounded by a thin strip of tympanic membrane. The

Fig. 4.

handle of the malleus tips inward, becomes horizontal and is seen foreshortened. Shrapnell's membrane is left unaffected and the tympanomallear folds are usually bordered by a narrow strip of pars tensa (Fig. 4).

This type of perforation corresponds to no particular form of otitis. It usually causes a greater impairment of hearing than do the other types. Cholesteatoma is frequently encountered (35 per cent of cases). According to the features, three treatments may be taken into consideration, viz.: only medical treatment if otorrhea is purely mucosal or if the fundus tympani shows a tendency to epidermization; atticotomy if otorrhea is mucopurulent, copious and profuse; antroatticotomy with removal of the incus and head of the malleus if foul suppuration suggests antro-atticotympanic suppuration or if a cholesteatoma is discovered.

The surgical decision, aided by audiographic findings, is made after resection of the attical wall. It should be as conservative as possible and should not be extended to radical mastoidectomy. That is never necessary in children in whom the tympanic membrane must always be respected.

A large tympanic destruction, with an irregular, granular, "caviar-like" fundus tympani, covered here and there with a whitish coat which cannot be pulled off, a cavity littered with fetid lumps not originating from cholesteatoma, is very probably of tuberculous origin. Evidence can be obtained from skin reactions, inoculation of guinea-pigs and investigations into the history and into other possible localizations.

SUMMARY

Very little has been written on chronic otitis in children. Yet it is different from chronic otitis in adults. Classical textbooks advise only medical treatment before the age of seven (it fails in most cases) and radical mastoidectomy in case of life-threatening complications.

This is an attempt to classify children's chronic otitis in five forms (of which one, atticotympanic mucopurulent suppuration, is peculiar to the young child) and a plea for a simple limited operation performed whatever the age, atticotomy, which acts propitiously on discharge and preserves hearing. The chief factor of chronicity is the swelling of the epitympanic mucosa. Simple mastoidectomy is ineffective. Radical mastoidectomy is too severe. These conclusions are founded on 194 operations on children followed up during seven years of otoscopies and audiograms.

39 RUE COPERNIC

9 RUE DE LATREMOILLE

VII

THE CLINICAL SIGNIFICANCE OF THE VALLECULA

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While, at first hand, the vallecula may seem to possess relatively little clinical importance in otolaryngology, every now and again the clue to some diagnostic problem may be found in this area. Furthermore I am convinced that many times morbid conditions in this region are overlooked. This may result from failure to do a mirror laryngoscopy routinely or, in doing so, to focus attention upon the glottic picture, neglecting what might be significant findings at the base of the tongue.

Numerous articles in the literature have called attention to the all too frequent disregard of the nasopharynx and its diagnostic importance, stressing the necessity of careful and thorough examination of this region. While in no way intending to diminish its importance, I have come to feel that, second only to the nasopharynx, the vallecula is the commonly neglected region, and without the possible excuse of relative inaccessibility. In the adult patient, especially, the vallecula may have considerable clinical significance.

The late John Sea had an aphorism he was fond of repeating and one worth remembering: "In the infant think of the adenoids; in the child, the tonsil; and in the adult, the lingual tonsil."

Normally the structures of clinical importance in the epiglottic vallecula are the lingual tonsil, the foramen cecum and the accompanying vascular supply. The first is prone to all the disorders of pharyngeal lymphoid tissue, including infection, hyperplasia and neoplasia, while the second may give rise to abnormal conditions of embryological origin.

The lingual tonsil is situated at the base of the tongue behind the circumvallate papillae and in front of the epiglottis. It consists of lymph nodules resting on a basement membrane of fibrous tissue which may extend across the tongue to the lower margin of the

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faucial tonsils. The mass is separated at about midline by a thin fibrous partition. Its lymphatics empty into the suprahyoid, the submaxillary and the deep cervical nodes. In contrast to the other elements of Waldeyer's ring the lingual tonsil has a tendency to become somewhat more prominent in adult life during the period of normal involution of the faucial and pharyngeal tonsil. Often enlargement is noted after removal of the former, possibly a compensatory reaction, although the exact cause of lymphoid hyperplasia is not thorough understood.

White,[1] working with experimental animals, found that adrenal cortical stimulation resulted in reduction in size of lymphoid tissue, while hypertrophy occurred following inadequate adrenal cortical secretion, as in adrenalectomized animals. He states that "the size and rate of growth of lymphoid tissue are influenced markedly by endocrine and dietary factors, as well as by a variety of physical and chemical stimuli, many of which exert their effects via an endocrine mechanism, in the pituitary-adrenal cortical axis." That the involution of lymphoid tissue of the faucial tonsils and adenoids at, or about, puberty has some relationship with the gonads is borne out by observations on experimental animals that castration causes a significant lymphoid hyperplasia and that injection of male sex hormone results in involution. The involution normally found in fasting animals was greatly reduced by prior gonadectomy. While "active secretion of the thyroid, controlled by the thyro-trophic hormone of the adrenohypophysis may acutely cause reduction of lymphoid tissue as a result of stimulation of adrenotrophic secretion" lymphoid hyperplasia may result from both experimental and clinical hyperthyroidism. Evidence all points to an intimate relationship between the endocrine glands and the size and growth of lymphoid tissue. White also suggests the probability of a genetic factor. This is borne out by the frequency with which clinicians see hyperplasia of Waldeyer's Ring in families running through two or three generations.

HYPERTROPHY OF THE LINGUAL TONSIL

Hypertrophy of the lingual tonsil may give rise to local symptoms of irritation, discomfort and tendency to frequent swallowing. This is a common cause of a "lump in the throat." There is usually a dry irritative cough, more marked at night, from pressure on the lymphoid mass on the epiglottis.

The enlargement may be such that at times it can be seen merely by depressing the tongue. Examination with the laryngeal mirror reveals the vallecula filled with lymphoid tissue which may touch or even partially cover the epiglottis. While the diagnosis generally

presents no difficulties, the possibility of cysts, lingual thyroid, or neoplasms must be kept in mind.

Mild symptoms due to hypertrophy of the lingual tonsils may be relieved by local applications of silver nitrate 10 per cent. When this does not suffice and symptoms warrant, the lymphoid tissue may be destroyed by electro-coagulation or removed surgically. With any marked degree of hypertrophy, surgery is preferred.

FOREIGN BODIES

The lingual tonsil is a favored landing place for certain foreign bodies, particularly fishbones. With a history of swallowing such a foreign body and failure to find it impacted in the faucial tonsil, careful search of the vallecula by means of the laryngeal mirror often will reveal the intruder projecting from the lingual tonsil. This may require the use of a local anesthetic to control gagging. Small fishbones, particularly if they have been swallowed sometime previously, may present quite a problem, as only the end may be projecting from the underlying lymphoid tissue. Once located, removal is easily effected by using an angular forcep, such as the Mackenzie type, under guidance of the laryngeal mirror.

LINGUAL TONSILLITIS

Acute lingual tonsillitis generally accompanies similar infections of the faucial tonsils, although not apt to be so evident in young children in whom the lingual tonsil may not be as prominent. In tonsillectomized individuals, however, the disease may be localized in the lingual tonsil.

The outstanding symptoms are dysphagia and a feeling of a lump in the throat. There is apt to be fever, headache, and salivation. Articulation may be impaired. Cervical adenopathy is common.

Mirror examination will show the lingual tonsil red and swollen and with characteristic white spots. These findings, with the history of acute onset usually confirm the diagnosis.

The treatment is similar to that of acute faucial tonsillitis; bed rest and appropriate antibiotic drugs together with warm saline gargles or irrigations.

ABSCESS OF THE LINGUAL TONSIL

Abscess of the lingual tonsil is due to localized infections generally secondary to acute lingual tonsillitis although sometimes resulting from surgical trauma, burns, or penetrating foreign bodies. The

symptoms are pain, dysphagia, salivation, and swelling at the base of the tongue. The voice is thick and there may be some interference with respirations. The cervical nodes usually are enlarged.

Mirror examination reveals the lingual tonsil red, with a swollen, sometimes fluctuant area, at one side of the midline. While conservative medical therapy may be employed in the early stages, with evidence of abscess formation, incision is indicated. This is done under topical anesthesia using an angular laryngeal knife with guarded blade, under the guidance of the laryngeal mirror. Generally the condition subsides after incision, although the possibility of edema of the larynx or spread of infection into the deeper tissues of the tongue and neck must be kept in mind.

KERATOSIS OF THE LINGUAL TONSIL

Keratosis of the lingual tonsil is quite similar to keratosis pharynges. Inasmuch as various fungi are found in these lesions it has been considered by many observers as primarily a chronic mycotic infection. Because of the frequency with which lepothrix has been isolated, Eggston[2] has suggested the specific designation of hyperkeratosis lepothrix for this condition. On the other hand it has been considered that the basic cause might be some metabolic disturbance, resulting in excessive cornification of the epithelium lining the crypts and that the fungi might be in the nature of secondary saprophytes. Other observers have classified the various fungi under the general term of actinomyces.

The symptoms are those of constant irritation, feeling of fullness and dry cough. Examination reveals yellowish white excrescences on the lingual tonsil and these may be pin-point in size, barely projecting above the surface of the surrounding membrane, or they may be large, irregular, and extending above the mucosa. There is no surrounding inflammatory reaction. The excrescences are very adherent to the underlying tissue.

Local treatment generally is ineffective. Removal of the excrescences usually is followed by recurrence. Local applications have little to recommend them. Correction of any metabolic disorder, and improvement in general well-being seems to offer the most.

CYSTS

Cysts of varying size may be found in the vallecula. These usually are retention cysts due to blocking of the ducts of mucous glands. They vary greatly in size and if large may give rise to symptoms of constant irritation, feeling of a foreign body, irritative cough, or even obstruction.

Diagnosis is usually obvious upon examination, although this may be missed unless the laryngeal mirror is employed.

Small cysts may be eradicated by careful electro-coagulation, employing topical anesthesia with cocaine, ten per cent solution. The cyst is picked up, and "speared" by the active electrode while the laryngeal mirror held firmly against the soft palate serves as the indifferent electrode. Large cysts are best managed by careful dissection unless sufficiently pedunculated to permit the use of a snare. Local anesthesia with cocaine, ten per cent solution, or intratracheal ether anesthesia may be employed. The mucous membrane covering the cyst is carefully incised using a sharp knife. Following this a narrow curved scissors of the Metzenbaum type, or a sharp submucous elevator is used to develop and remove the cyst.

Large cysts in the vallecula are more easily managed by using the laryngeal speculum or the Lynch suspension which allows the operator the use of both hands.

VARICOSITIES

Occasionally in older persons, dilated and tortuous veins may be seen on the base of the tongue in the vallecula on laryngeal examination. At times these have been considered as a possible source of bleeding, giving rise to blood-stained mucous. Considering the relative frequency of such varicosities without symptoms, however, any such assumption should be based upon the actual finding of oozing from this area. In that event electro-coagulation of the bleeding area, under local anesthesia, might be indicated.

LINGUAL THYROID

Lingual thyroid is a rather rare condition due to a developmental abnormality resulting in aberrant or accessory thyroid tissue at the foramen cecum. Statistics from a number of large thyroid clinics give the incidence of lingual thyroid as about one per 3,000 cases of thyroid disease. It is a benign tumor. Malignant degeneration is very rare.

The symptoms are those of a mass or foreign body in the throat and a constant desire to swallow. The tumor may be large enough to interfere with good articulation or to cause dyspnea especially at night when the recumbent position may allow the tongue to fall backward so that the mass may partially obstruct the airway. Varying degrees of bleeding may occur as the tumor is very vascular.

The lingual thyroid may represent the entire thyroid tissue, in which case it is considered as aberrant. If thyroid tissue exists simul-

taneously in the normal location the lingual thyroid is termed accessory. In the former type, where this represents the entire thyroid tissue, disturbances of functional activity may produce similar symptoms as in the case of the normally located gland.

Examination with the laryngeal mirror reveals a round, circumscribed symmetrical mass, sometimes lobulated, in the midline of the vallecula between the foramen cecum and the epiglottis. It is deep red in color. It is covered with normal mucous membrane through which may be seen many superficial veins. The tumor may be large enough to be seen by merely depressing the anterior part of the tongue and it may encroach upon the epiglottis, pushing it backward. It is easily palpable, is not tender, or fluctuant.

The diagnosis is based upon the characteristic appearance and location. It must be differentiated from such benign tumors as angioma, adenoma, fibroma, hemangioma, dermoid, and from simple hypertrophy of the lingual tonsil. Malignant tumors in this region are rarely mid-line but biopsy is always indicated to confirm the diagnosis.

If the tumor is of sufficient size to cause symptoms, surgical treatment is preferred to attempts to control the condition by radioactive iodine therapy. Efforts should be made to ascertain whether or not this represents the only thyroid tissue present, and caution exercised not to produce a myxedema by total excision. While the external route, either transhyoid or lateral pharyngotomy, has been employed, the intra-oral procedure is quite satisfactory and far simpler, offering direct access to the tumor.

Intratracheal ether anesthesia is used, providing an adequate airway throughout the operation. After the insertion of a mouth gag, stay sutures are inserted well back on either side of the tongue, enabling it to be drawn forward and bringing the tumor into view. After the tumor is grasped with forceps, incisions are made on either side and the dissection continued with curved scissors, working in an oblique direction toward the midline. If the operator is satisfied that this does not represent the entire thyroid tissue of the patient, that it is actually accessory tissue, the tumor may be completely removed. In any case of doubt a subtotal removal should be done. Interrupted silkworm gut sutures are used to close the wound. These may be removed by the fourth or fifth day.

There may or may not be disturbing bleeding, although this is more apt to occur with subtotal operation. Suction should be constantly at hand to facilitate accurate hemostasis. Proper selection of

the endotracheal tube and packing the hypopharynx should protect the bronchial tract from aspiration.

While preliminary tracheotomy has been advocated by some operators this hardly seems necessary with a properly performed intratracheal anesthesia. However, the surgeon should be prepared to perform tracheotomy should hemorrhage occur in the immediate postoperative period, when further deep suturing may be required.

In cases where subtotal removal is indicated, the diathermic or electrocoagulating snare can be employed under either local anesthesia, infiltrating the surrounding area with procaine, or intravenous pentothol sodium. This latter method is not without risk due to the possibility of laryngospasm adding to the amount of obstruction and, even with the use of curare, intubation of the trachea would be advisable.

Considerable reduction in size may be effected by simple electrocoagulation of the mass under local anesthesia. However, if the tumor is of a size to produce significant symptoms, at least, a subtotal removal would seem indicated.

The prognosis should be good unless inadvertently all thyroid tissue be removed, with a resulting myxedema.

CARCINOMA

In contrast to neoplasms of the faucial tonsil or of the tongue, midline carcinomata of the lingual tonsil are quite rare and may go unrecognized until cervical adenopathy results in careful search of the area. These are generally of the squamous cell type. Symptoms may be quite non-existent until the neoplasm has achieved sufficient size to encroach on the epiglottis, or spontaneous bleeding directs one's attention to its source in the vallecula. Usually these come, or are referred, because of an enlarged cervical node, often with no complaint referrable to the pharynx although mirror examination easily reveals the primary lesion.

Obviously these cases present a very poor if not hopeless prognosis. By the time they might be recognized even the most radical surgery would seem to offer but little and radiation therapy is much less effective than in carcinomata of the faucial tonsil.

In one of our cases the patient presented a large mass in the right carotid triangle of some two months' duration. Despite what was considered as a careful search nothing significant was found in examination of the nasopharynx, pharynx, or larynx. Exploration of the neck revealed what appeared to be a mass of inflammatory

nodes adherent to the carotid sheath. Histopathological report was metastatic squamous cell carcinoma—Grade I. The primary lesion was only revealed one week later when spontaneous bleeding from the vallecula directed attention to that area. While the primary lesion was smal in size and deep in the pre-epiglottic sulcus a more careful search, utilizing topical anesthesia, should have resulted at least in earlier diagnosis.

SUMMARY

The vallecula frequently holds the clue to certain clinical conditions of importance. Failure to recognize these may be due to disregard of routine and systematic use of the laryngeal mirror. Hypertrophy of the lingual tonsil, acute lingual tonsillitis, abscess of the lingual tonsil, keratosis, cysts, varicosities, and foreign bodies in this area are clinical entities of significance. While not commonly seen the lingual thyroid and carcinoma of the lingual tonsil are conditions which should not be overlooked. The vallecula would seem to possess considerable significance to the otolaryngologist.

PROFESSIONAL BLDG.

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VIII

MANAGEMENT OF PHARYNGOSTOME, ESOPHAGOSTOME AND ASSOCIATED FISTULAE

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Radical surgery in the neck directed at the extirpation of malignant tumors of the tongue, floor of the mouth, lateral palate, mandible, pharynx, larynx, cervical esophagus and lateral neck occasionally necessitates the creation of a pharyngostome and esophagostome. When primary reconstruction of the wound is prohibited due to a lack of essential tissue the elective pharyngostome and esophagostome is mandatory. In the absence of an elective pharyngostome and esophagostome, an extensive neck wound may be complicated by the development of a postoperative fistula. These situations extend the morbidity, often require one or two additional operations to close the opening, and increase the distress to the patient. The most efficient treatment embraces measures to prevent fistulae, newer techniques to keep the creation of pharyngostome and esophagostome at a minimum, and surgical methods for the proper handling of these situations once they exist.

In planning a radical surgical operation on the pharynx, larynx or esophagus, both the excisional and reconstructive phases of the operation must be analyzed. The excisional surgery must, without compromise, include an adequate operation for the cancer. Reconstruction of this locality is concerned primarily with the restoration of the pharynx and cervical esophagus. The food passage is reconstituted either with mucous membrane remaining in the wound after the excisional phase of the operation has been completed when this tissue proves to be adequate, or the substitution of new tissues to form an appropriate lining and covering for the new tube.

There are various combinations of circumstances requiring pharyngo-esophagostome but the dominant factor is the absence of mucous membrane lining. When all of the pharyngeal mucosa is resected in a combined pharyngectomy and laryngectomy, the elective creation of a pharyngostome must be considered. When a radical dis-

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section of the lateral neck contents is included in the above procedure the same criteria hold. When less than 30 per cent of the pharyngeal mucosa remains in a wound, a pharyngostome may be necessary, although certain substitution techniques described later in the article have decreased the advisability considerably. When malignant tumors of the cervical esophagus have increased in size to cause partial obstruction of that passage, it is always necessary to resect the entire circumference of the esophagus. If an esophagectomy is accompanied by a pharyngectomy, laryngectomy and neck dissection, an esophagostome and pharyngostome must be considered.

Approximately 20 per cent of the patients undergoing radical excision of the pharynx, larynx, esophagus and lateral neck with primary closure develop a leak of some type and degree. Although the vast majority of these unexpected fistulae will close spontaneously within two to four weeks, a situation may develop where surgical intervention may be required. This troublesome complication prolongs the morbidity and may develop into a permanent pharyngostome.

The etiological factors associated with fistulae formation are: 1) infection of the wound, 2) stitch dehiscence, 3) poor tissue bed, 4) poor surgical judgment, 5) lack of stabilization and support of the wound.

In the past, infection was the most common cause of complicating pharyngeal and esophageal fistulization. The wound was unavoidably contaminated with saliva during the excisional phase of the operation and was potentially infected. The principal offending organisms were hemolytic and nonhemolytic streptococcus and staphylococcus and pseudomonas aeruginosa. There was edema of the tissues about the repaired mucosa and often secondary infection penetrating into the cancer and into the lymphatic drainage bed. These obvious handicaps rarely seriously interfere with the healing of the wound today if ample biotherapy is administered.

The dehiscence of a single or even several stitches can rarely cause fistulization. However, if a series of individual stitches dehisce in the presence of localized infection and saliva, one can expect fistulization. The fistulae resulting from primary stitch dehiscence are usually small and close spontaneously almost without exception.

Poor tissue bed is an important factor in the failure of wounds to heal. This may be the result of intensive irradiation into these areas in an unsuccessful effort to cure the cancer. The late effects of intensive irradiation associated with fibrosis and atrophy have a very serious effect upon the healing of the wound. Ischemia of the mucous

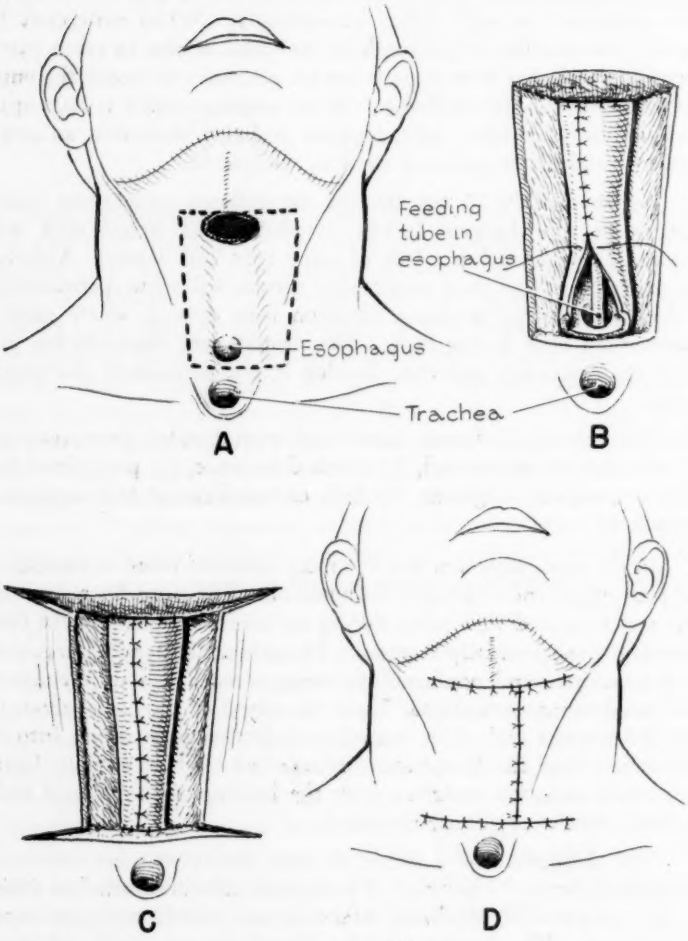

Fig. 1.—Postlaryngopharyngectomy with pharyngo- and esophagostomes corrected by use of local tissue flaps in a one-stage operation.

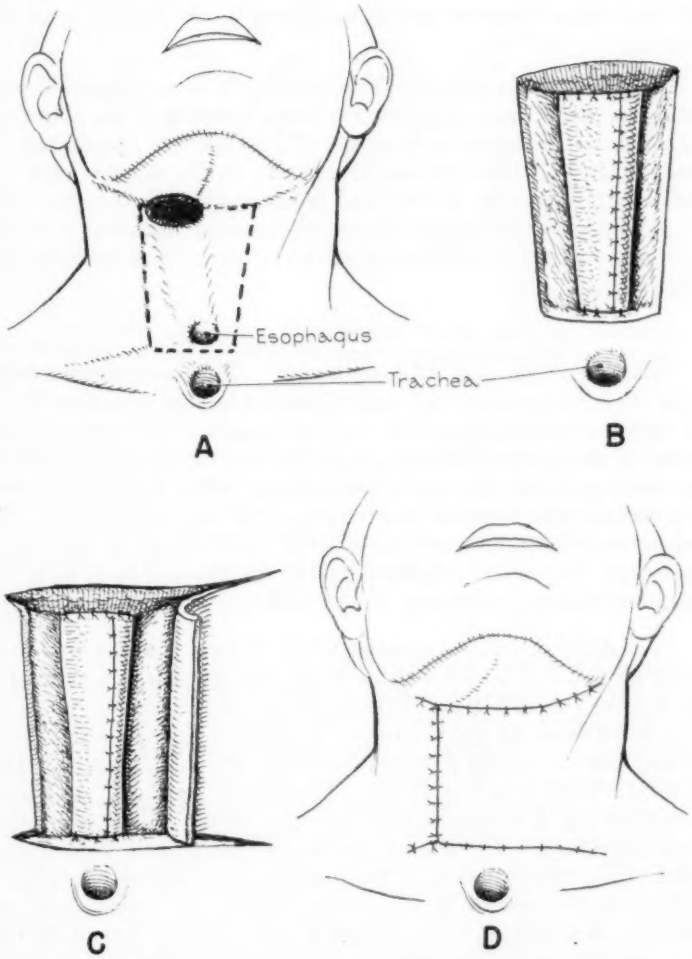

Fig. 2.—Postlaryngopharyngectomy and right lateral neck dissection with pharyngo- and esophagostomes corrected by use of local tissue flaps in a one-stage operation. This closure may be tight and require supplementary skin grafting.

membrane and skin flaps from inadequate blood supply may cause necrosis and resultant fistulization. Other factors contributing to poor tissue bed, such as anemia, debilitating diseases, poor nutrition and poor tissue character are all conducive to the formation of fistulae.

The dressing about the neck wound may be contributory to poor healing in that it may constrict and cause ischemia of the skin flaps and subcutaneous tissue or compress the suture line against the indwelling feeding tube with undue pressure on the mucosa. On the other hand, it may be so loose and nonsupportive in character that the wound is not stabilized during the myriad movements of the head and neck, thus preventing primary union, with eventual fistulization.

TYPES

Esophagostome and Pharyngostome: There are three general types of pharyngostomes and esophagostomes created intentionally for the expeditious handling of the surgical wound. The character and extent of the primary disease govern the size, shape and position of the pharyngostome and the esophagostome when immediate reconstruction of the pharynx and esophagus is not anticipated. The position may be anterior or lateral. The stomata may be separate or combined. The size is regulated by the amount and position of the mucous membrane remaining in the neck.

1. After the radical resection of the larynx, pharynx and cervical esophagus and lateral neck, a large pharyngostome is created at the superior portion of the pharynx and an esophagostome just above or to one side of the tracheostome. If there is a minimal amount of residual mucosa on the posterior or lateral pharyngeal walls, it may be incorporated into the repair. Frequently, however, all mucosa is resected and it is necessary to cover the wound with lateral transposed neck flaps. The pharyngostome is created by sewing the cut edges of the adjacent skin of the superior neck flaps to the adjacent mucosa which remains in the wound around the tongue and oropharynx, thus making a direct open repair. A large fenestrum connects the skin of the neck with the oropharynx. The esophagostome is created in a similar manner by suturing the mucous membrane of the cervical esophagus to the skin of the inferior neck flaps. It should not be directly associated with a tracheostome because of the hazards of regurgitation and aspiration of gastric contents.

2. If a radical or subtotal pharyngectomy (and glossectomy) and neck dissection are performed without a laryngectomy, then the

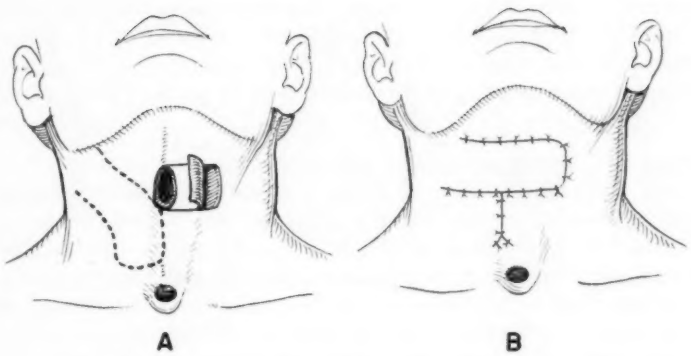

Fig. 3.—Pharyngostome (or fistula) in healthy tissue bed, following laryngectomy and partial pharyngectomy, closed by local tissue flaps in one-stage operation.

resultant mucosa is not sufficient to accomplish a primary repair, a large combined pharyngo-esophagostome may be created in the anterior or lateral portion of the neck. This situation presents only a single opening. Yet with the larynx in situ, the hazard of aspiration is increased. A low tracheostomy should be in position until after the opening is surgically closed and the patient can swallow without difficulty.

3. It may be desirable in some instances, where the resection of the tissues of the neck has been so extensive, such as in total glossectomy, pharyngectomy, laryngectomy, cervical esophagectomy and bilateral neck dissection that the repair of the food passages will be greatly delayed, to create only an esophagostome. The site where a pharyngostome would ordinarily be positioned is closed off completely by the direct approximation of the residual mucosa in the pharynx and then the skin closed over this. The oral cavity is eliminated from the wound and this prevents saliva from passing through, thus permitting better healing of the neck and relieving the patient of the inconvenience of saliva constantly running onto the neck.

Fistula: There are four general types of fistulae occurring as a complication of surgery on the neck. Their size, shape and position in the neck are governed by the magnitude of the contributing etiological factors.

1. The most common type of fistula encountered in the past was that associated with total laryngectomy. As a result of stitch

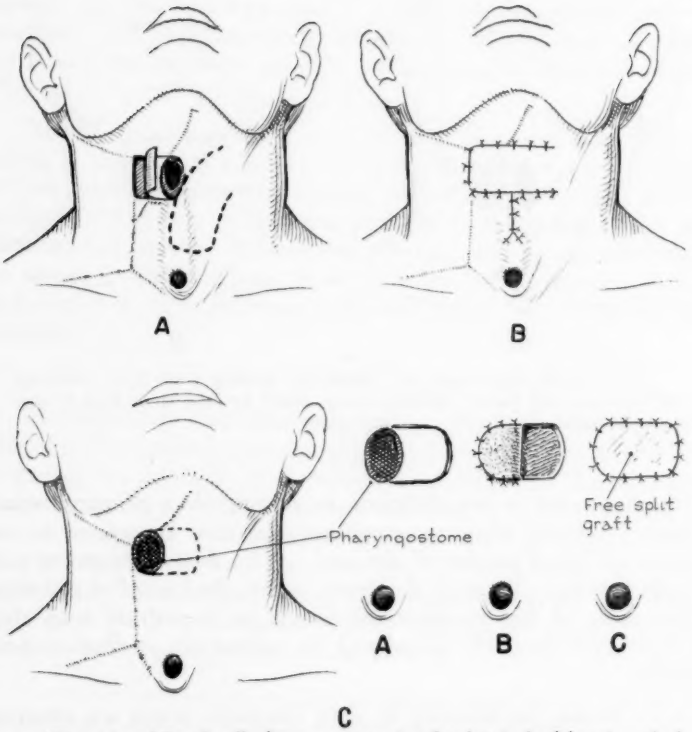

Fig. 4A and B.—Small pharyngostome (or fistula) in healthy tissue bed following composite resection of larynx, pharynx and lateral neck contents, repaired by local tissue flaps in one-stage procedure.

Fig. 4C.—Same status repaired by local tissue flap and free skin graft in one-stage procedure.

dehiscence and localized infection, a small fistula occurred at any site in the repair of the pharyngeal mucosa. In almost all of these instances, the fistula was only temporary, closing spontaneously within a period of two or three weeks. If, on the other hand, the fistula was large in character, it became a permanent part of the wound and specific surgical intervention was necessary to correct it. The growing tendency to include elective neck dissection in extrinsic cancer of the larynx has altered this situation.

2. An unexpected fistula may follow the radical excision of the larynx, pharynx, cervical esophagus and lateral neck contents. The fistula, under these circumstances, is usually larger than that

associated with simple laryngectomy. It is usually located in the side of the neck, but may occasionaly appear under the chin. It always exists in the suture line. Small fistulae in this category close spontaneously in one to four weeks. Very large ones have also closed spontaneously in three to four weeks, but frequently require surgical reconstruction.

3. Fistulae may occur following radical resection of the tongue, pharynx, larynx and unilateral or bilateral neck contents. This is particularly true if the mandible remains in situ creating a large submandibular dead space. This fistula is usually large and situated at a higher position in the neck, associated more often with the immediate pharyngeal area than with the dependent hypopharyngeal area. Many of the individuals undergoing these radical procedures have been previously unsuccessfully treated with irradiation, thus causing a marked devitalization of the entire tissue bed. In addition there is often deficient mucosa for the immediate repair, particularly when it has been necessary to resect the entire tongue and floor of the mouth. These fistulae, as will any fistula, diminish in size remarkably in four to eight weeks, but almost always require reconstructive surgery.

4. Fistulae may occur as a complication when there is an attempt to do an immediate reconstruction of the pharynx and cervical esophagus by the implantation of a tubed, free, split skin graft, with the assistance of an indwelling stent or mold. The factors of infection of the graft, poor nutritional bed, undue pressure on the tissue flaps and inadequate drainage of the wound lead to loss of essential tissue. Even a small loss (5 per cent) of the skin graft may be complicated later by stenosis at this site if the stent is not permitted to remain in situ for six months. Fistulae are not common with this technique. Small ones usually close spontaneously in two to three weeks. If the complication is extensive, it may be necessary to remove the graft and stent and begin a delayed multiple stage reconstruction by the use of associated tissue flaps.

SURGICAL CORRECTION

The application of the surgical principles involved in dealing with stomata and prophylactic measures to prevent fistulae, greatly facilitates the management of these problems. Adequate repair of the pharyngeal wound in the postlaryngectomized and pharyngectomized patient is a most important factor. The two repairs in common usage today are the T type and crescent-shaped type of repair. The T-type contains a basic central structural weakness where the root of the T unites with the cross bar. The crescent-shaped type

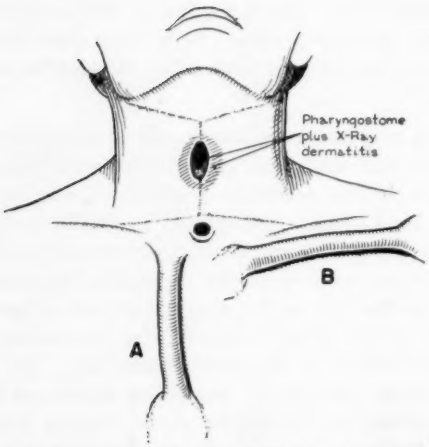

Fig. 5.—Pharyngostome (or fistula) following laryngectomy and partial pharyngectomy in irradiated bed, closed by tubed infraclavicular or chest flap.

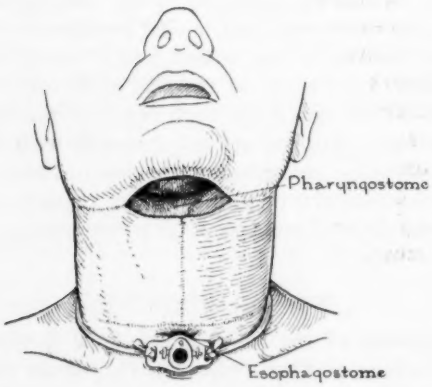

Fig. 6.—Pharyngostome with communication into mouth in total glossectomy, pharyngectomy, laryngectomy and bilateral neck dissection.

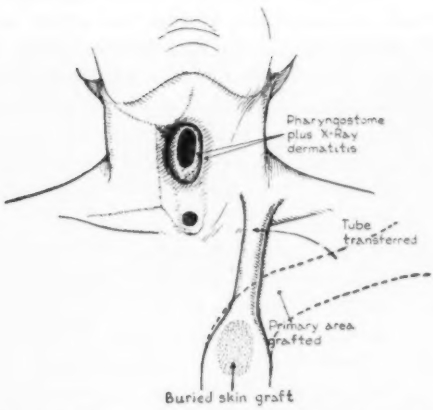

Fig. 7.—Large pharyngostome in postirradiated bed following composite resection of larynx, pharynx, and lateral neck contents, repaired by large tubed chest flap with skin lined tip. (Note: The tube should not cross the midline when being prepared.)

is superior when this can be carried out without undue tension. A careful approximation of the mucosa with interrupted #000 chromic catgut sutures followed by the approximation of the muscularis with interrupted #000 chromic catgut sutures, reinforced by a third layer of interrupted #000 chromic catgut sutures containing fascia and areolar tissue offers the best opportunity for the prevention of fistulae. A careful search with the finger may disclose areas requiring additional suturing before the wound is closed. Approximation of the skin flaps in two layers with fine silk gives maximum external security.

Adequate dependent drainage of the wound is essential to prevent pocketing of serum and blood and to enable it to heal per prima. A supportive but nonconstrictive dressing obliterates wound dead space and helps prevent saliva from entering the wound.

In the past the adult sized Levine tube which was used for feeding purposes was certainly contributory to the formation of some fistulae, particularly in the cases where there was a minimal amount of mucosa left for the repair. The elimination of rubber from these reconstructed passages and the substitution of the plastic tube measuring from 3 to 5 mm in diameter is helpful. Feedings through these plastic (acrylic) tubes are carried out by the use of the syringe or drip technique.

If a fistula develops on the first or second postoperative day it is usually the result of inadequate closure and repair of the pharyngeal passage. However, the majority of fistulae appear after approximately seven days. This is usually the result of stitch dehiscence or infection of the wound. All small fistulae will close spontaneously within a period of one to three weeks without any surgical intervention. Direct approximation of the skin and subcutaneous tissue may be carried out in moderate sized fistulae that are slow in healing. If the fistula is large and has occurred as a result of an infection and stitch dehiscence and exists in a postirradiated tissue bed or in association with extensive scar formation and involves not only the pharyngeal mucosa but also the soft tissues of the neck and even the skin of the neck, surgical closure by tissue flap transplantation is necessary. If one can be patient, even these very large openings will diminish in size considerably, thus making the fenestrum a smaller surgical problem. The insertion of plastic tubes or inert compounds as a temporary expedient to prevent the leakage of saliva in these instances has not been very helpful.

When there is a paucity of pharyngeal mucosa and it is desirable to attempt a primary repair, two techniques are most helpful. By flexing the head it is possible to mobilize the base of the tongue inferiorly to the level of the cervical esophagus. A direct suture at this level creates mucous membrane continuity from the oral cavity to the cervical esophagus in the anterior half of the food passage, when a total pharyngectomy has been done. It is often impossible to mobilize enough mucosa in the total pharyngectomy to cover the prevertebral fascia completely because of the fixity of the mucosa in that area. If the raw surface is not greater than 4 x 4 cm it may be permitted to heal by secondary intention. The scar formation may cause some slight narrowing of the pharynx but can be dilated by bougies or digitally by the patient. The tightness resolves within six to twelve months and the technique merits consideration under these special circumstances.

The closure of the large infrahyoid pharyngostome or esophagostome by the Wookey technique or a modification of his technique has become a well established surgical principle. Indeed, it offers a very satisfactory method of repair in a reasonable period of time and provides an excellently functioning pharyngeal and esophageal passage. The technique consists of the utilization of one of the anterior neck flaps for the creation of the posterior aspect of the anticipated swallowing tube during the repair of the wound at the time of the primary operation. After an interval of from two to four weeks, the proximal portion of this flap is detached and a skin tube created

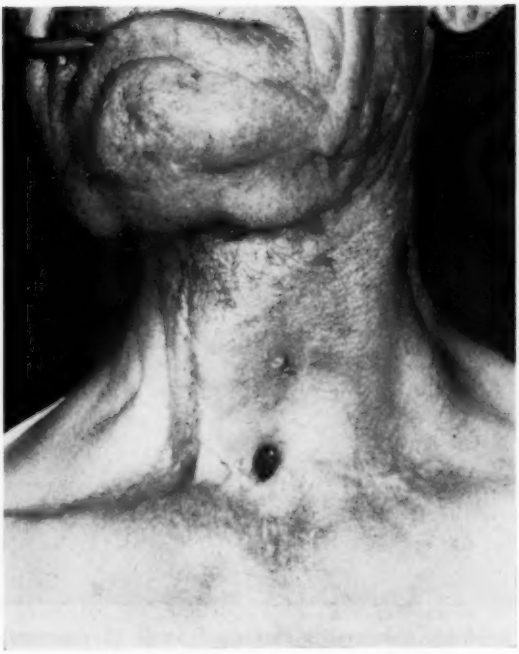

Fig. 8.—Small fistula in the central anterior neck, associated with epithelial skin graft over wire mesh stent. This fistula closed spontaneously.

by rolling it inward and connecting it to the opening in the pharynx and the esophagus. The raw area is covered, either by rotation of another adjacent neck flap or the application of a free skin graft (Fig. 1). If it is possible to close these wounds without the use of a free skin graft the result is almost always superior. The Wookey technique lends itself best when the excisional operation has not included a unilateral or bilateral radical neck dissection, the removal of the hyoid bone or a portion of the base of the tongue. When these latter techniques are included, and today the radical surgical principles applied to the treatment of extensive cancer of these organs includes these latter techniques, the Wookey procedure becomes less applicable and must be modified (Fig. 2).

The elimination of a pharyngeal or esophageal opening may be accomplished in a single operation or may require the transposition of tissue from an adjacent area of the lower neck or chest with multiple

Fig. 9.—Large postoperative pharyngeal fistula (laryngectomy, radical neck) due to wound infection and stitch dehiscence closed by simple resuturing of the wound.

surgical procedures. The factors determining the precise type of surgical repair are governed by the magnitude of the primary operation, the size and position of the stoma, the availability of tissues in the local area and the intrinsic quality of the tissue bed.

The utilization of the tissues adjacent to the stoma is the most expedient and simplest method of repair. This technique lends itself best in the simple, nonirradiated postlaryngectomy situation where a large fistula has developed. If a classical midline vertical incision has been made for laryngectomy the wound is closed in a single operation by the inversion of a trapdoor type of flap to create epithelial covering internally and the rotation of an adjacent flap to dress the wound. All wounds are closed by direct approximation in a single stage procedure (Fig. 3). Delay under these circumstances is not indicated. This same technique can be applied to the closure of a pharyngostome where the deficiency of pharyngeal mucosa is limited to the area of the fenestrum.

If a laryngectomy, partial pharyngectomy and right (or left) radical neck dissection has been performed, and a permanent stoma of not more than 2 cm in diameter has developed, it also can be closed by the use of an adjacent inverted flap and the rotation of a covering pedicle flap from the immediate vicinity in a single one-stage operation (Fig. 4). It may be necessary under these circumstances to use a small free graft over the donor area (Fig. 4C).

If a fistula has developed following a partial pharyngectomy, laryngectomy and bilateral radical neck dissection, one must consider the use of reparative tissue from an area other than the neck in many circumstances. A tube raised in a horizontal or oblique line in the infraclavicular area or in the vertical line of the parasternal area is best suited. It should be of sufficient length and width to accommodate the distance and close the fistula in two or three surgical steps (Figs. 5 and 6). If the fistula is very small in these circumstances, one might be tempted to attain closure by the use of local tissue flaps. However, the availability of neck skin which can be moved safely when a bilateral radical neck dissection has been performed is indeed minimal. Although the acquisition of supplemental skin in the form of a pedicle flap prolongs the morbidity, there is no other satisfactory alternative (Fig. 7).

The use of skin from the infraclavicular area or anterior chest wall is also indicated in fistulae which have developed in a heavily irradiated tissue bed or in excessive scar tissue, whether the operation has been a simple laryngectomy or has included the unilateral or bilateral radical neck dissection. Under these circumstances, the fistula is frequently quite large in size. The preparation of the pedicle flaps must be carried out on a grander scale. Special care must be taken to close the wound completely without any tension on the pedicle flap. Suturing these wounds in individual layers with a separate approach to the lining or inner surface and the external or skin surface is desirable. One can rarely use the associated tissues which have been heavily damaged by irradiation or scar formation for the inverted internal lining flap. Consequently, the pedicle flap must contain an inner lining on the portion which is to be used to repair the fistula.

The handling of the scar tissue about the fistula is important in the surgical revision. Temporization, postoperatively, with the justified expectancy that the fistula will become smaller, permits the fistula to diminish primarily by scar tissue contracture. This scar tissue has partially closed the fistula and if it is totally excised in preparing the wound for closure, a great increase in the dimensions of the wound will occur, even to the degree of prohibiting the one-

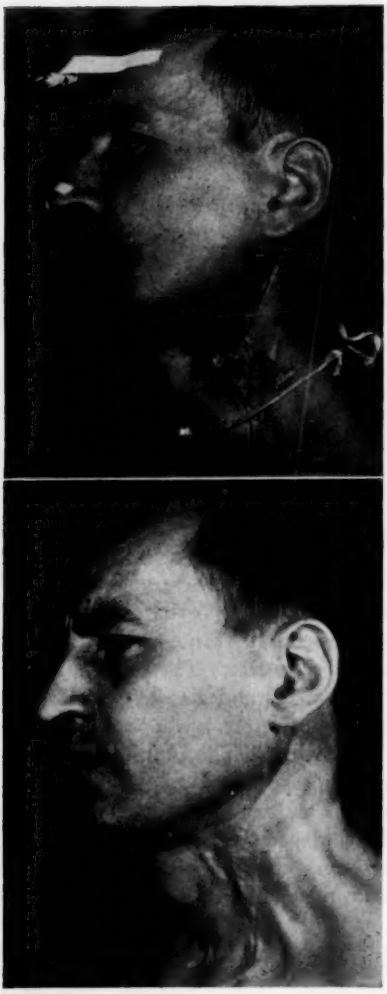

Fig. 10A and B.—Lateral pharyngostome (following neck dissection and pharyngectomy) closed by use of local flaps.

stage procedure. This fundamental principle of excision of all scar tissue is altered, therefore, so that the scar tissue is retained as a helpful force about the fistula in all cases where local tissues are to be used in a one-stage reparative procedure and the tissue bed has not been damaged by irradiation. The scar tissue should not form the base of the tissue flap, however, because of its lack of adequate blood supply. When abundant supplemental tissue is being transposed into the wound via a tubed flap from the chest, the irradiated and scar tissues are removed to improve the tissue bed.

In the male the growth of hair in the newly constructed tube from inverted or transposed tissue flaps may be controlled by clipping or irradiation. Its presence, however, is distressing and inverted hair-bearing flaps for internal lining should be avoided when possible.

SUMMARY AND CONCLUSIONS

Infection, stitch dehiscence and poor tissue bed are the principal etiological factors in causing pharyngeal fistulae. Ample biotherapy and proper handling of the repair of the wound mitigate this complication. The vast majority of uncomplicated small fistulae heal spontaneously within one to three weeks. The larger fistulae associated with radical surgery of the neck are closed in a one-stage operation. Large fistulae plus postirradiation ulceration require the use of transposed neck or chest flaps in single or multiple operations, depending upon the availability of adequate healthy tissue.

The pharyngostome and esophagostome are intentioned surgical maneuvers carried out in the absence of sufficient mucosa to effect immediate closure and are usually associated with extensive resection of the pharynx, larynx, esophagus and neck. They are constructed so that spontaneous closure is not to be anticipated. Delayed repair of these deficiencies is carried out in two to four weeks after the primary operation. Small stomata in healthy tissue beds are closed by the use of associated neck flaps in a single operation. Large stomata in heavily irradiated tissues or in extensively operated areas (bilateral neck resections) are closed in multiple stage operations with chest flaps.

Vocal rehabilitation is fair. Swallowing efficiency depends primarily upon the diameter of the newly constructed tube. It is usually good and rarely requires dilatation.

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IX

MOBILITY OF THE STAPES IN CHRONIC MIDDLE EAR SUPPURATION

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With development of surgical methods for the treatment of hard-of-hearing patients, greater interest in the study of the pathologic physiology of hearing is seen and it has become an important problem. The study of sound conduction in the inner ear is an important part of sound conduction and because of this the pathologic condition of the oval and round windows is extremely important. The problems of these windows has come to be studied more closely with progress in the study of otosclerosis and development of methods for its treatment. Great importance was first attached to the condition of the oval window and this was followed by observations and studies on the condition of the round window.

Of cases of chronic otitis media treated recently by the author by surgical methods, the stapes were observed in 99 and the condition of mobility examined. The results are presented here.

MOBILITY OF THE STAPES

The state of mobility of the stapes was examined with a probe but cases were found in chronic purulent otitis media where the head of the stapes, one or two crus of the stapes, etc. were missing and these, with parts of the stapes absent, were deleted from this study. A problem which arises in the study of mobility of the stapes is whether there has been dislocation of the stapes during operative procedures. In cases where the incus is removed, the incudostapedial joint is first dislocated, so during the procedure care was always taken to push the incus forward and upward in order to prevent this.

The results thus obtained are shown in Table I.

As can be seen, in 99 cases of chronic purulent otitis media, the stapes was fixed in 8 per cent and mobility slightly disturbed in 8 per cent, that is, mobility was poor in 16 per cent. Compared to this, in 17 cases where conventional radical mastoidectomy was per-

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TABLE I.—MOBILITY OF THE STAPES

MOBILITY	O. M. P. C.	AFTER RAD. OP.	OT. M. ADH.	TOTAL
Good	83	10	3	96
Slightly Disturbed	8 16%	3 41%	0	11
Fixed	8(8%)	4(23%)	2	14
Total	99	17	5	121

formed and in which ear discharge was still present, ankylosis of the stapes was found in 23 per cent and when those showing some disturbance of mobility are added, mobility was poor in 41 per cent.

It can be seen from this, that a danger of the mobility of the stapes becoming poor is present in cases in which granulation tissue becomes covered with epidermis following radical mastoidectomy. The question then arises whether a special pathological change takes place in the tympanic cavity in chronic middle ear suppuration in cases where mobility of the stapes is poor. If this were true, then it should be possible to ascertain the state of mobility of the stapes prior to surgery. A study of the changes in the tympanic cavity in cases where mobility of the stapes was poor was carried out and the results are shown in Tables II and III.

TABLE II.—PATHOLOGICAL CHANGES IN TYMPANIC CAVITY OF PATIENTS WHOSE STAPES WERE FIXED

CASE	TYMPANIC CAVITY	MALLEUS	INCUS	OTHERS
1	Thickened mucous membrane	Carious	Carious	
2	Cholesteatoma	Missing	Missing	Post. crus miss.
3	Abundant granulation	Covered with gran.	Missing	
4	Abundant granulation	Carious	Missing	
5	Cholesteatoma	Normal	Normal	Promontory carious
6	Granulation, Formation of new bone	Missing	Carious	Osteomyel. temp. bone
7	Abundant granulation	Carious	Normal	
8	Mucous membrane thickened	Normal	Carious	

It can be seen that in these cases where mobility of the stapes is fixed, both incus and malleus are normal in some while in others the incus or the malleus is missing. In other words, there is no direct relationship to the condition of the two outer ossicles. The condition

TABLE III.—PATHOLOGICAL CHANGES IN TYMPANIC CAVITY OF PATIENTS WHOSE STAPES WAS SLIGHTLY DISTURBED IN MOBILITY

CASE	TYMPANIC CAVITY	MALLEUS	INCUS	OTHERS
1	Mucous membrane thickened	Carious	Missing	Facial nerve exposed
2	Granulation	Normal	Normal	
3	Hard connective tissue	Missing	Carious	
4	Hard connective tissue	Carious	Carious	
5	Mucous membrane thickened	Only head left	Normal	
6	Hard granulation	Carious	Normal	
7	Granulation	Carious	Carious	Osteomyelitis of temporal bone
8	Hard granulation	Carious	Carious	

is also observed accompanying various changes in the soft tissue in the tympanic cavity as thickening of the mucous membrane, abundant growth of granulation tissue, cholesteatoma, etc.

In cases where mobility of the stapes is slightly disturbed too, both the incus and malleus are normal in some while one or the other is missing in others and there is no relationship between the condition of the two outer ossicles and mobility of the stapes. A constant alteration also is not found in the soft tissue of the tympanic cavity and there is only a thickening of the mucous membrane in some while there is abundant granulation in others. Hard connective tissue was however found in a relatively large number of cases.

It is suggested from the data in Table II and III that disturbance in mobility of stapes is not always due to proliferation of connective tissue and that inflammatory regeneration of bone plays an important role. A constant pathological change, however, is not found in tympanic cavity.

The problem then becomes how to diagnose the mobility of the stapes in chronic middle ear suppuration prior to surgery. Such methods as comparison of acuity of hearing before and after covering the round window niche with a cotton pledget or using a sound probe are utilized. A report on these methods and the results has already been published.[5] It is, however, not possible to determine the degree of mobility of the stapes even with these methods. The results obtained with these tests, in cases where the pathological changes in the tympanic cavity are left intact, differ from those obtained when the pathological changes are removed. For example, in cases where there is no improvement in hearing but a worsening on loading of

the round window niche, it is generally assumed that there is ankylosis of the stapes but a like result is seen when there is granulation present in the stapedial region and round window niche even when the mobility of the stapes is good. Poor mobility of the stapes is presumed when an increase in the threshold is found with the sound probe test, but a similar result is obtained when the ossicular chain is interrupted.

It must therefore be concluded that the mobility of the stapes can be determined by mobility tests only at the time of surgery.

COMMENT

In otosclerosis, good or poor mobility of the stapes is highly important in treatment. That is, the fenestration operation is indicated in those showing stapes ankylosis, while surgery is not indicated in those in which mobility is in part disturbed. On the other hand, various problems are presented in regards to its relationship to ankylosis of the round window.

In 1953, Tobeck[4] examined the mobility of the stapes in 200 cases at the time of fenestration surgery and reported that there was complete fixation in the majority, slight mobility remaining in a few and mobility was normal in only 11. A study was made of the relationship between the degree of hearing disturbance and the mobility of the stapes in 19 cases where mobility was poor, and varying degrees of hearing disturbance were present. There was no relationship between poor mobility and poor hearing.

Zöllner[6] has stated, together with many other investigators, that the stapes is easily fractured in the process of removing the incus, and when one crus is broken, the mobility of the head of the stapes increases. Therefore, when mobility is to be determined by direct contact with the stapes at the time of surgery, extreme care is required.

The author, too, did not consider the effect on the stapes too greatly when removing the incus surgically in 1952. Cases were experienced where the stapes was dislocated and loose, and at times the stapes was inadvertently removed in the process of removing granulation tissue in the stapedial region. Since 1954, however, the incus has been removed carefully with the technique already reported. Differing from otosclerosis, there is little fracture of the stapes, but dislocations are more frequent in chronic middle ear suppuration. In chronic middle ear suppuration, therefore, the mobility of the stapes can be examined directly by taking the necessary care in removing the incus and by using the above technique for removing granulation tissue.

At the present time, when the object of treatment in chronic middle ear suppuration is not only the alleviation of the inflammation but the restoration of hearing, the condition of the two labyrinthine windows is extremely important in relation to sound transmission in the inner ear. From this viewpoint, testing of the mobility of the stapes in chronic middle ear suppuration is an absolute requirement.

A problem which now confronts us is how to treat cases of chronic middle ear suppuration in which mobility of the stapes is poor.

The author published a report in 1953[1] in which he stated that cases with good mobility of the stapes should be treated by the "enhanced hearing radical mastoidectomy, Method I"[2] and those in which the stapes is rigid be treated by the "enhanced hearing radical mastoidectomy, Method II"[2] which combines the former method with fenestration. Cases in which the mobility is partially disturbed, however, were not discussed at that time. The reason for this was that cases with partially disturbed mobility of the stapes were divided into two groups and Method I was carried out in one and Method II in the other, and we investigated the progress of each group. Before a sufficient number of cases of each group could be collected, however, surgical techniques were improved and procedures in the stapedial region became more delicate, with greater care in removing connective tissue attached to the stapes and section of the stapedial tendon. With these procedures cases in which mobility of the stapes improved increased, and cases requiring fenestration decreased. It is of interest here to note that Rosen[3] has described a procedure for improving mobility of the stapes in otosclerosis without resorting to fenestration. It was believed that improvement of mobility of the stapes in chronic middle ear suppuration would be much simpler than in otosclerosis and recently it has been the policy to avoid fenestration as much as possible and strive to remove the tissues hampering movement of the stapes.

The problem which now arises is whether proliferation of connective tissue in the reparatory processes following removal of the connective tissue and others hampering mobility will again become so great as to obstruct mobility. Rosen has stated that in cases with good hearing, observed for a period of over a year after treatment, the mobility of the stapes is unchanged and has claimed that the improvement in mobility is a lasting effect. The author is using the technique of injecting Varidase into the newly formed tympanic cavity in order to prevent this proliferation of connective tissue. It has been shown histologically by experimental middle ear cavity for-

mation studies that connective tissue is not formed in the stapedial region by the use of Varidase.

CONCLUSIONS

The mobility of the stapes was examined directly in 99 cases of chronic middle ear suppuration treated surgically and it was found that the mobility disturbance is less than in cases where radical mastoidectomy had already been carried out. It is suggested from these facts that these differ from cases in which two-step surgery for restoration of hearing is planned and drying of the tympanic cavity by radical mastoidectomy is first carried out, and a secondary operation for restoration of hearing is then conducted.

With the method and care described by the author, there is little postoperative alteration in the mobility of the stapes. With removal of the pathological changes hampering mobility and section of the stapedial tendon in cases where mobility is poor, it is possible to obtain a lasting improvement in mobility.

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X

IN VITRO CULTURE OF THE ISOLATED OTOCYST OF THE EMBRYONIC FOWL

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The development of the otocyst of the embryonic fowl was first described by Fell[3] who used a technique developed by Strangeways and Fell[1] for the study of the self-differentiating capacity of avian organ rudiments. In these experiments the otic vesicle of the three-day old fowl embryo was cultivated on the surface of a plasma-extract clot formed at the bottom of a centrifuge-tube. The developing otocysts were transplanted every 48 hours onto a freshly prepared medium.

There are no further reports until 1953 when Lawrence and Merchant[4] described some attempts at maintaining otocysts without transplantation for seven to eight days in Porter flasks. The results achieved with this method fell far behind those reported by Fell[2] partly because the over-all time in vitro was too short to allow full differentiation.

In the experiments of the present writers isolated otocysts were grown by the watchglass method.[3] The degree of self-differentiation observed was higher than in the earlier papers. In particular the organ of Corti and the macula showed full differentiation when compared with the development of the sensory epithelium of the inner ear of chick embryos of similar age (Fig. 1).

The work here described was undertaken as a preliminary study for investigations on the effect of chemical and other agents on the ear.

MATERIAL AND METHODS

The material consisted of the otocysts of three and a half day fowl embryos (Fig. 2). Both sides were cultured and fixed at suitable intervals for sectioning. It was found useful to leave some tissue around the otocyst and not to trim it down too much.

From the Department of Pathology and Bacteriology, The Institute of Laryngology and Otology, London, with the technical assistance of Mr. E. S. Bird.

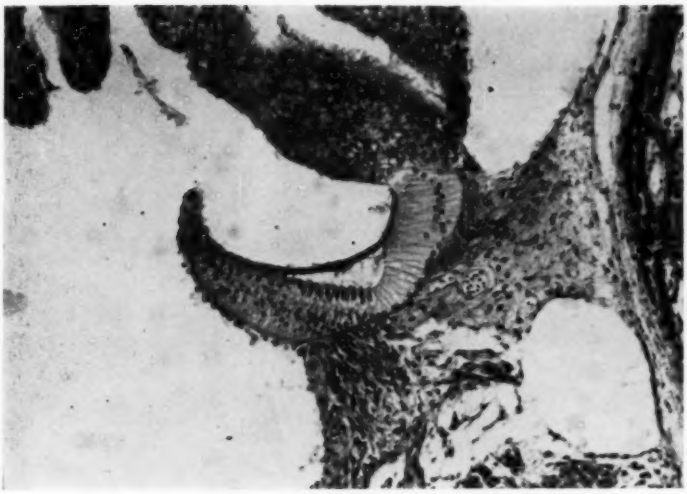

Fig. 1.—Organ of Corti showing tectorial membrane hair cells and clear limbus cells. Fifteen-day old fowl embryo. Periodic-acid-Schiff reaction. X 260.

The medium was usually composed of two parts of fowl plasma (not stored for more than eight to ten days) and one part of embryo extract made from 12 to 13 day old embryos with Gey's balanced salt solution. The usual total amount of nutrient was 2.25 ml giving a large enough clot in the watchglass freely to accommodate four otocysts. The developing tissue was transplanted to fresh medium every two days and was usually maintained for 11 to 13 days.

The explants were fixed in Carnoy's solution for 30 minutes. Sections were stained by the periodic-acid-Schiff method.

RESULTS

The otocyst enlarged considerably during its development in vitro, and the mesoderm by which it was surrounded usually differentiated into a horseshoe shaped or circular cartilaginous capsule (Fig. 4) which during the later stages of growth showed signs of ossification (otic capsule). Cartilage formation was the rule and not, as in Fell cultures, the exception mainly because more of the mesenchyme surrounding the otocyst was retained at the time of inplantation. The cultivated otocyst, as pointed out by Fell, tended

to preserve its original vesicular form throughout the culture period, but not infrequently there was definite branching and some evidence of the development of semicircular canals.

The capsule sometimes restricted the extension of the otocyst and when of irregular shape caused the otocyst to become deformed, but this did not necessarily affect the development and differentiation of the sensory epithelium.

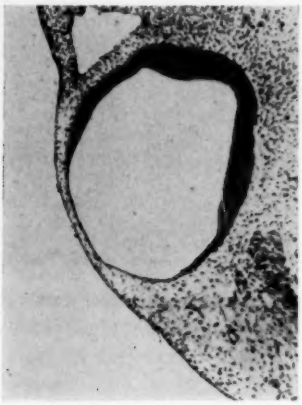

Fig. 2.—Isolated otic vesicle of 3½-day old fowl embryo. Haematoxylin-eosin. X 72.

On histological examination it was seen that up to about the end of the first week the epithelial lining of the otocyst showed considerable mitotic activity and gradually increased in thickness. The endolymphatic duct enlarged and its epithelium became cuboidal or columnar.

By about the tenth day, the epithelial lining of the main vesicle of favourable explants showed clear signs of differentiation into structures resembling the various parts of the sensory epithelium of the inner ear in normal fowl embryo of comparable age. The following regions could be distinguished in the inplants: Corti's organ, the macula and crysta-like structures.

The characteristic features of the organ of Corti were well developed. As described by Fell[2] the hair cells had the typical thistle-head shape and appeared to penetrate into the tectorial membrane covering the surface of Corti's organ (Figs. 5-7). The sensory ele-

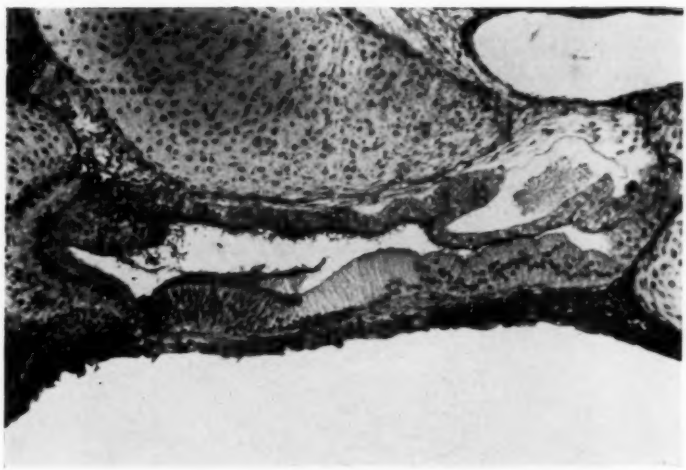

Fig. 3.—Tissue culture of isolated otic vesicle 11 days in vitro (14-15 days over-all age) showing organ of Corti (see also Fig. 7). Periodic-acid-Schiff reaction. X 250.

ments were adjoined by tall clear cells resembling those of the spiral limbus of the normal ear from which the tectorial membrane originates (Figs. 3 and 5). The development of Corti's organ usually reached its maximum by about the twelfth to thirteenth day of cultivation.

The hair cells of the macula were easily recognizable and rested on a basal layer of sustentacular cells which were particularly well developed in these areas (Figs. 8-10). The sensory cells were covered by an otolithic membrane which stained positively with the periodic-acid-Schiff reaction.

In several otocysts crysta-like structures could be observed covered by material staining pink with the periodic-acid-Schiff reaction and forming what is probably the cupola (Figs. 11 and 12).

Beyond the cartilaginous capsule there was usually some fibroblastic or epithelial outgrowth. The latter, often keratinized and formed small epidermoid cysts filled with lamellated keratinized material resembling the matrix of the so-called aural cholesteatoma.

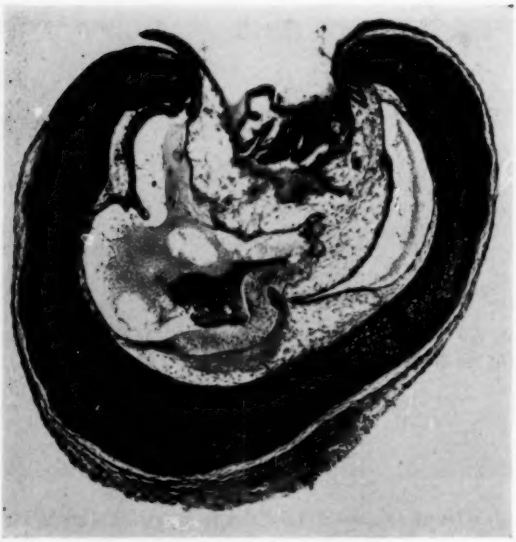

Fig. 4.—Tissue culture of isolated otic vesicle 13 days in vitro (16-17 days over-all age). Otocyst surrounded by semicircular cartilaginous capsule. Periodic-acid-Schiff reaction. X 76.

COMMENT

The results confirmed that the isolated otocyst of the embryonic fowl has a striking capacity for histological self-differentiation. This capacity appeared to be somewhat enhanced when some of the surrounding tissue was included in the explant; otocysts which became surrounded by a cartilaginous capsule of circular or semicircular shape appeared to develop particularly well. This is in agreement with Fell's recent observation.[5] Fell found that in a medium containing a high concentration of Vitamin A the otocyst differentiated normally, but was much smaller than its control; this apparent retardation of growth may have been, according to Fell, a secondary effect attributable to the complete suppression of the cartilaginous capsule by the vitamin.

There was no evidence that 48-hourly transplantations had any untoward effect on the development of the otocyst as suggested by Lawrence and Merchant.[4] The method adopted by these authors appears to be less suited for the study of the development of the

isolated otocyst than the watchglass-method[3] which, though more laborious, produces a high degree of differentiation.

SUMMARY

1. The otocysts of 3½-day fowl embryos were cultivated in vitro by means of a watchglass technique.

2. It has been confirmed that the explanted otocysts have considerable powers of self-differentiation.

3. The watchglass technique proved very suitable for this study as the degree of differentiation thus achieved was higher than previously reported.

4. The organ of Corti and the macula in particular showed complete and characteristic differentiation when compared with the normal development of the sensory epithelium of the inner ear of fowl embryos of similar age.

INSTITUTE OF LARYNGOLOGY

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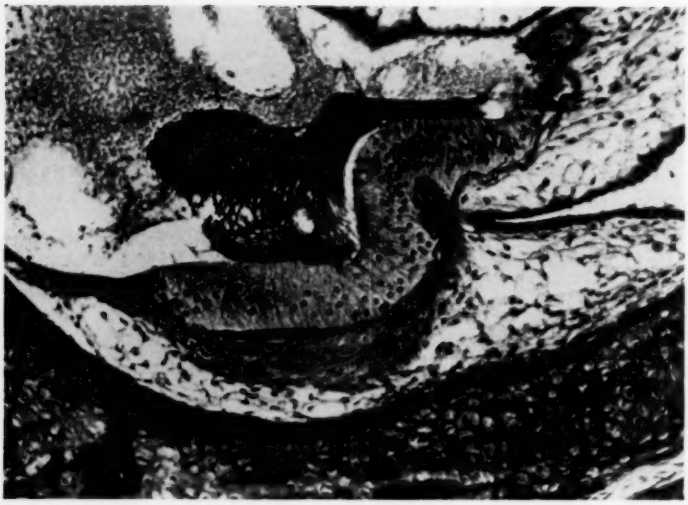

Fig. 5.—As Fig. 4. Showing Corti's organ covered by dense layer of material staining red with the periodic-acid-Schiff reaction, forming tectorial membrane. X 290.

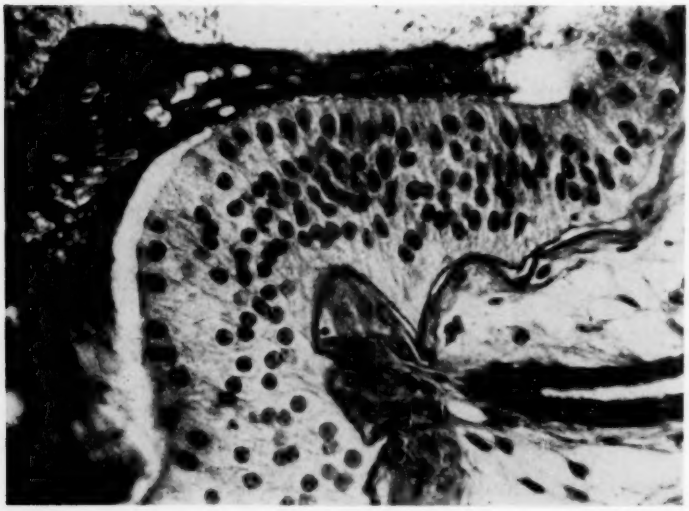

Fig. 6.—As Fig. 5. Note hair cells with hair-tufts penetrating into the tectorial membrane. Periodic-acid-Schiff reaction. X 750.

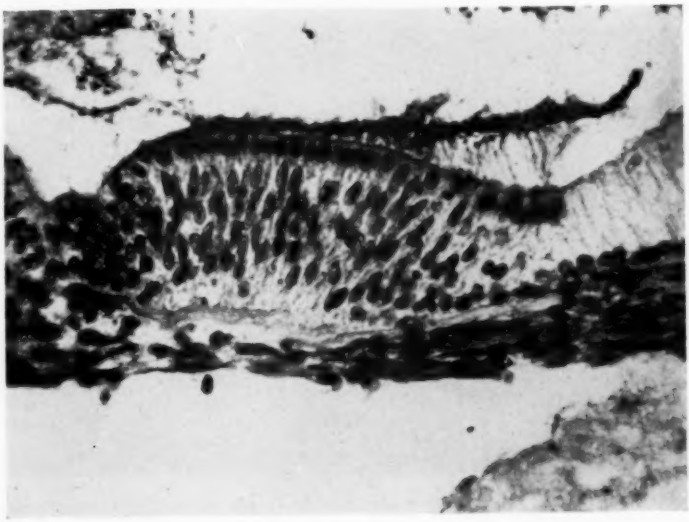

Fig. 7.—As Fig. 3. Note nuclei of hair cells and of Deiter's cells of Corti's organ (11 days in vitro). Periodic-acid-Schiff reaction. X 650.

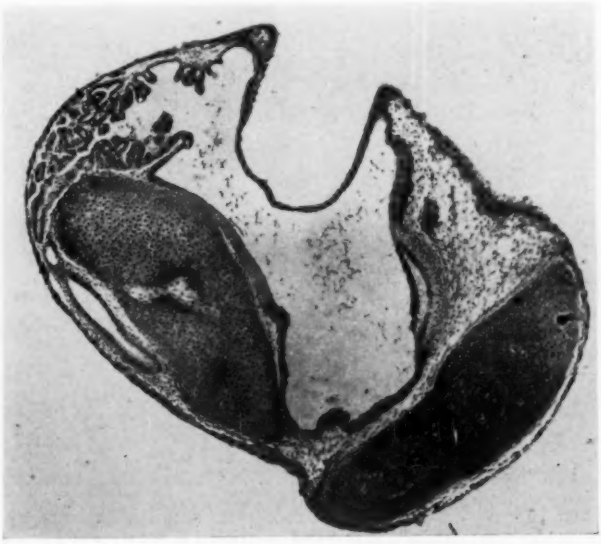

Fig. 8.—Tissue culture of otic vesicle 11 days in vitro (14-15 days overall age) showing macula. Periodic-acid-Schiff reaction. X 72.

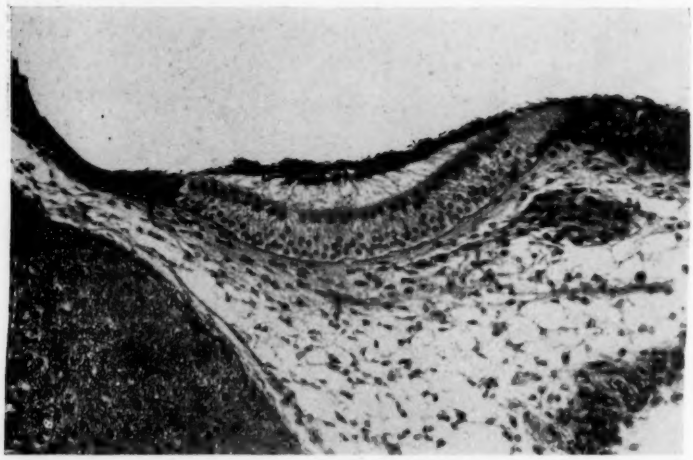

Fig. 9.—As Fig. 8. Showing cells of macula and otolithic membrane. Periodic-acid-Schiff reaction. X 310.

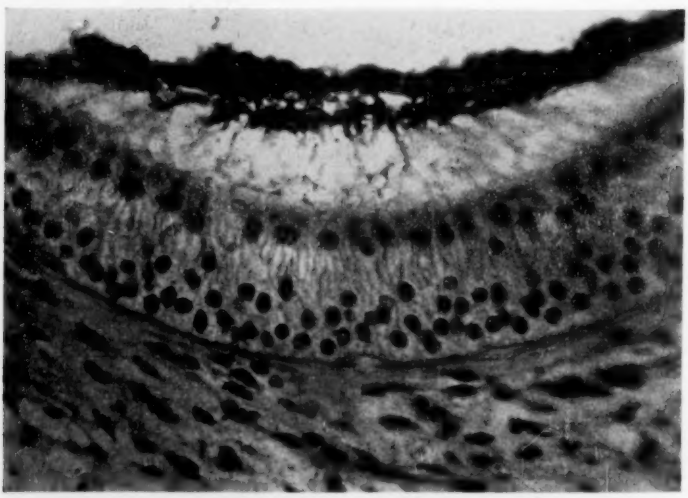

Fig. 10.—As Fig. 9. Note hair cells of macula with basal layer of sustentacular cells. Periodic-acid-Schiff reaction. X 800.

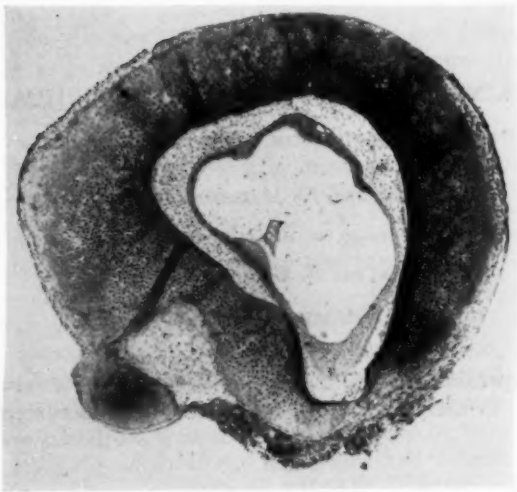

Fig. 11.—Tissue culture of isolated otic vesicle 11 days in vitro (14-15 days over-all age) with crista-like structure with cupola. Periodic-acid-Schiff reaction. X 60.

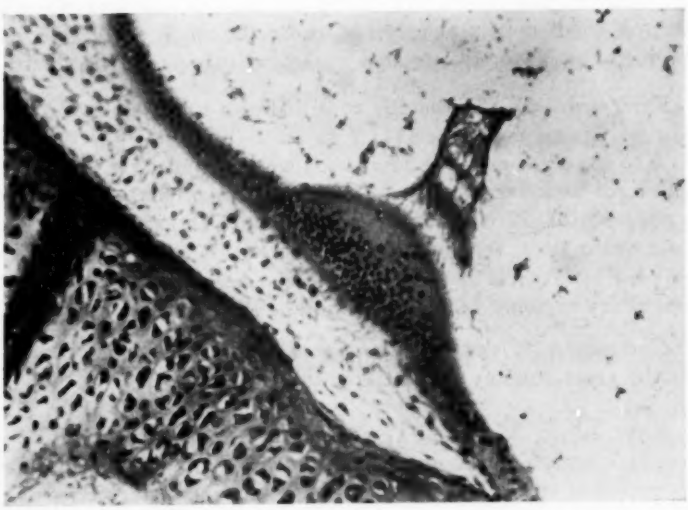

Fig. 12.—As Fig. 11. Showing crista-like structure. Periodic-acid-Schiff reaction. X 340.

XI

PRIMARY CARCINOMA OF THE UVULA

A REPORT OF SEVEN CASES

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AND

RALPH F. BOWERS, M.D.

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Little mention is made in the literature about the uvula and its neoplasms. Primary carcinoma is indeed a rare occurrence in the uvula.

REPORT OF CASES

CASE 1. H. D., a 59-year-old white male, was admitted to Kennedy Hospital on June 1, 1949. He smoked one pack of cigarettes daily. He gave a history of sore throat, mild dysphagia of three months' duration, and a small mass below the angle of the left jaw for two months. Examination revealed a fungating lesion of the uvula extending from its base along the arch of the left posterior pillar. A small node was palpable under the angle of the left and right mandible. Biopsy revealed squamous carcinoma, Grade II.

Treatment. X-ray therapy consisted of a tumor dose of 3850 r to the left lateral pharynx, 4111 r to the right lateral pharynx, and 4665 r to the right neck. Radon seeds were implanted into the node of the right neck for a total of 4781 gamma roentgens and also into the node of the left neck for a total of 13,182 gamma roentgens. Nine months later, recurrent nodes appeared in the left neck along with pain in the left jaw, and induration and swelling in the left submaxillary region. He died six months later from the carcinoma.

Comment. It is obvious that the disease was not controlled even with the great amount of radiation therapy.

CASE 2. E. W., a 51-year-old white male, was admitted to Kennedy Hospital on August 26, 1949, complaining of a sore throat for a period of two months. He smoked one pack of cigarettes daily.

From the Otolaryngological Section, Surgical Service, Veterans Administration Medical Teaching Group Hospital, Memphis 15, Tennessee.

Examination revealed a granular lesion which replaced the uvula and extended from the base to the free edges of the soft palate. No neck nodes were palpable. Biopsy of the uvula revealed squamous cell carcinoma, Grade I.

Treatment. Treatment consisted of wide excision of the lesion. To date, six years later, there is no evidence of recurrence of the lesion and no cervical node metastasis.

Comment. This is one of the few patients with primary carcinoma of the uvula who has survived five years or more.

CASE 3. J. W., a 58-year-old colored male, was admitted to Kennedy Hospital on February 22, 1950, complaining of sore throat, increased salivation, mild dysphagia for six months, and a 25-pound weight loss during the past year. He used cigarettes moderately. Examination revealed a granular ulcerated lesion of the uvula which extended along the edges of the soft palate and tonsillar arches bilaterally. A deep cervical node was palpable on each side of the neck. Biopsy of the uvula revealed squamous carcinoma.

Treatment. Radiation therapy induced a total tumor dose of 5592 r to the primary site. Radon seeds were implanted into the cervical nodes. Four months later, carcinoma of the lower third of the esophagus was discovered which caused his death in June 1951. There was no gross recurrence at the primary site and no other nodes appeared in the neck. Autopsy findings revealed primary carcinoma of the esophagus with metastases to the right lung, pleura, liver, thoracic and abdominal lymph nodes, and spine. Disapprovingly enough, the microscopic examination of the uvular region revealed squamous carcinoma but no involvement of the cervical lymph nodes.

Comment. There was recurrence of carcinoma in the primary site 16 months after radiation.

CASE 4. H. M., a 63-year-old white male, was admitted to Kennedy Hospital on March 3, 1953, with a history of a sore throat for several years' duration, a non-tender swelling in the right upper neck for ten days, and a small swelling in the left upper neck which, he stated, developed following tonsillectomy 15 years previously and which had not increased in size. He has been a heavy pipe smoker for years. Examination revealed a granular, roughened, strawberry-like lesion on the posterior surface and tip of the uvula which extended to the base. An olive-sized node was present under the angle of the mandible bilaterally. Biopsy revealed undifferentiated squamous carcinoma. Since the patient stated definitely that the node

on the left side had been present for years, it was removed for study. The pathologist reported it to be metastatic squamous cell carcinoma.

Treatment. The primary lesion was excised and radical neck dissection recommended. However, the patient refused this operation and 4280 r were applied to the pharynx and neck nodes. The patient's skin would not tolerate a heavier radiation dose. On October 6, 1953, large adherent nodes were discovered in the right upper neck for which 1680 r were applied in 12 days. Approximately seven months later, another 2000 r were applied. However, these right-sided nodes increased in size and became fixed and infiltrative. The patient continued to lose weight, became debilitated and emaciated, and died in January 1955, twenty-two months after diagnosis was established. There was no recurrence of the lesion at the primary site. Autopsy findings showed metastatic carcinoma of the right cervical nodes, right lung, and kidneys.

Comment. It is interesting to note that therapy handled the lesion at the original site very satisfactorily, but failed to do as well with the cervical metastasis.

CASE 5. H. C., a 47-year-old white male, was admitted to Kennedy Hospital on August 4, 1954, complaining of sore throat, dysphagia, and pain in the roof of his mouth for the past three months. He smoked one pack of cigarettes daily and drank beer and whiskey occasionally. There was bilateral cervical lymph node involvement. Biopsy revealed poorly differentiated squamous carcinoma.

Treatment. A tumor dose of 6848 r was applied to the primary lesion in 32 days. Radical neck dissection on the right was performed on December 5, 1954, and two months later the same operation was carried out on the left side. The nodes removed from the neck at both operations were positive for metastatic carcinoma. When checked October 10, 1955, patient showed no evidence of disease.

Comment. The primary lesion responded satisfactorily to irradiation. It is believed that bilateral neck dissection would permit a better prognosis than if x-ray therapy were employed for the cervical node metastasis.

CASE 6. E. L., a 65-year-old white male, was admitted January 18, 1955, to Kennedy Hospital complaining of a sore throat for the past year and smarting in the roof of his mouth for six months. He has smoked one pack of cigarettes daily for years. Examination revealed a dirty-gray, granular lesion at the tip of the uvula which extended down to the base. No neck nodes were palpable. Biopsy

revealed moderately well-differentiated squamous cell carcinoma. The lesion was excised surgically. When examined nine months later, no evidence of recurrence was noted.

Comment. Radical neck dissection will be employed if metastatic cervical nodes develop and the primary lesion is satisfactorily controlled.

CASE 7. R. B., a 62-year-old white male, was admitted to Kennedy Hospital on April 4, 1955, complaining of mild dysphagia, repeated hawking, and smarting and soreness high in the throat for the past eight months. Examination revealed a granular, raspberry, eroding lesion which replaced the uvula and extended from its base to the edges of the soft palate and tonsillar arches on both sides but more on the left. No neck nodes were palpable. Biopsy of the uvula revealed squamous cell carcinoma.

Treatment. Treatment consisted of irradiation by an intraoral cone and two external lateral fields, applying a total tumor dose of 6160 r in 23 days. Three months later, patient demonstrated no primary recurrence.

Comment. The follow-up period is too short for significant appraisal.

COMMENT

Carcinoma of the uvula infiltrates early and irregularly into the soft palate and palatine arches. Thus at times wide surgical removal may be difficult and, in such cases, irradiation may be the treatment of choice. However, in small lesions complete surgical excision is usually preferable and is attended by prompt wound-healing. If no cervical nodes are involved at the time of admission, no further surgery is performed. The patient should be examined at frequent intervals for recurrence in the primary site and for metastasis in the neck. Radical neck dissection should be employed at once if cervical node metastasis appears and, in this instance, radical surgery is far superior to radiation therapy.

Embryology and Histology. In embryological development of the face and jaw Patten[1] states that toward the end of the second month, the palatal shelves begin to make their appearance. The main part of the palate is derived from that portion of the upper jaw which arises from the maxillary processes. The palatine shelf-like outgrowths arise on either side and grow toward the midline and fuse, forming the roof of the mouth. The posterior portion forms the soft palate and uvula in which the bone does not develop. Ewens[2] ad-

vanced a theory that the uvula is a mere vestigial remnant of an upward regressing velum found in lower animals.

Smith and Copenhaver[3] describe the soft palate and uvula as being lined on its oval surface by a noncornified, stratified, squamous epithelium which extends for a variable distance over the soft palate onto the pharyngeal surface where it becomes continuous with pseudostratified epithelium. The submucosa is loose and contains many mucous glands with a number of small, skeletal muscles making up the uvula.

Anatomy and Structure. The uvula projects from the middle of the posterior free margin of the soft palate as a conical, pendulous process. Arching lateralward and downward from the base of the uvula on either side are two curved folds of mucous membrane containing muscular fibers called the arches, or pillars, of the fauces. It is composed of a mass of mucus, racemose glands, and alveolar tissue covered by a mucous membrane, and it contains slender prolongations of the uvular muscle in its upper contractile part. The uvular muscle consists of a pair of slender slings that lie side by side under cover of the superficial fibers of the pharyngopalatinus muscle. The musculus uvulae arise from the posterior nasal spine and the palatine aponeurosis and unite as they pass backward to enter the uvula being inserted in its mucous membrane. The uvula shows great variation in length; in some people it is short and blunt, in others it is long and thin and its tip may extend downward to the dorsum of the tongue.

Blood and Nerve Supply. The uvula has a very good blood supply from the parent arterial branches that supply the soft palate. These are the ascending palatine from the facial artery, the palatine branch from the ascending pharyngeal, and twigs from the greater palatine of the internal maxillary. Since the soft palate shares in the blood supply of neighboring structures, it thus receives branches from the tonsillar branch of the facial artery and dorsal lingual branch from the lingual artery.

The sensory nerve fibers run to the uvula from the sphenopalatine ganglion through the middle and external palatine nerves. The motor supply is the accessory nerve through the pharyngeal plexus. The tensor veli palatini which elevates the uvula is innervated by the mandibular nerve.

Lymphatics of the Uvula. There is a very rich capillary lymphatic network in the uvula. The finer lymphatics form collecting trunks which pass from the inferior surface of the soft palate and palatine arches and make up grouped vessels. According to Rouviere,[4] they follow three different directions. Consequently, there

is an anterior lymphatic path which leads to the submaxillary nodes, a middle path which goes to the deep lateral nodes of the neck, and a posterior path which terminates in the retropharyngeal nodes.

Rouviere[4] states the middle path is always present and that one of these collecting trunks constantly empties into an anterior subdigastric node. According to Sassier,[5] the anterior path is present in about 50 per cent and the posterior path present in 60 per cent. The middle path is crossed whereas crossing in the anterior and posterior paths exists in only 50 per cent of the cases.

Efferent lymph vessels pass to the middle and lower nodes of the internal jugular chain. Collecting vessels from the retropharyngeal nodes lead to the deep cervical chain. Some vessels of the pharynx may by-pass the retropharyngeal nodes and go directly to the nodes of the deep cervical chain.

Functions of the Uvula. Richardson and Pullen[6] list the following functions of the uvula:

"1. It massages and moistens cellular structure of posterior pharyngeal wall.

"2. It aids in the removing of material from the posterior pharyngeal wall and in the passing of this material downward to the hypopharynx and the base of the tongue.

"3. It serves as a transfer organ to bridge the deficiency between the velum and the posterior pharyngeal wall as secretion moves from the midline above and anteriorly to the midline posteriorly.

"4. It is a valuable aid in preventing middle ear disease in children.

"5. By participating in the preservation of normal pharyngeal arches the uvula prevents pharyngitis sicca with subsequent drying of the eustachian orifices as might be expected with a high arch on one side or with a fibrous straight-line contracture.

"6. It is the warning flag of the pharynx in many instances.

"7. It prevents rhinolalia aperta in successful tonsillectomy and is a valuable adjunct to voice control, possibly as a midline buttress, particularly in singers. This function is of little value in the speaking ranges apart from preventing unpleasant qualities.

"8. A uvula deviating to one side or the other side may indicate a weakness of the nerve on the opposite side."

The uvula is subjected to repeated airblasts during respiration, participates in the use of the voice and in deglutition, and is exposed to dry, hot inhalations of smoke in smoking.

Statistical Data. Stout[7] reviewed the literature of fifty years prior to 1916 and found nine cases of primary carcinoma of the uvula. In two cases, reported in detail, one had a recurrence in two months and the other within a year after surgical removal.

Robb and Michels[8] reported two cases and stated that surgery prior to metastasis to cervical nodes apparently offers better prognosis than irradiation alone.

Tremble and Lockhart[9] reported a case in which the uvula and greater part of the soft palate were excised. The patient was then given deep irradiation and even though it was believed that the tumor had been completely removed surgically. Twenty months later, there was no evidence of recurrence.

Four additional cases of primary carcinoma[10-13] and two cases associated with leukoplakia[14,15] are reported. Myxo-endothelioma[16] and melanoma[17] are rarely located in the uvula. It is possible that primary carcinoma of the uvula is more common than one suspects because when extensive, it could well be included in other neoplastic reports. But as far as we can ascertain, only 16 primary cases have been reported at the time of this writing. This does not include the cases reported above.

Martin[18] is of the opinion that the high incidence of metastasis of soft palate carcinoma is due to the mobility of this structure, which favors the detachment of tumor emboli. Since the uvula is very mobile, the same can apply to it so far as metastasis is concerned.

SUMMARY AND CONCLUSIONS

Seven cases of primary carcinoma of the uvula are briefly reported. In four of these cases (57 per cent), cervical lymph node metastasis was present on admission.

Five patients have survived six years, 16 months, 13 months, 8 months, and five months without evidence of disease. Two patients died, one at 22 months and the other at 15 months. The experiences with these cases suggest that surgical excision followed by radical neck dissection, if cervical lymph nodes appear, seems to be the therapy of choice. Radiation therapy to the primary site has proved to be satisfactory if surgery cannot be employed. However, its use in the cervical node involvement is inferior to the benefit gained by surgical operation.

PARK AND GETWELL AVES.

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XII

ON CIGARETTE SMOKING, BRONCHIAL CARCINOMA AND CILIARY ACTION:

III. ACCUMULATION OF CIGARETTE TAR UPON ARTIFICIALLY PRODUCED DECILIATED ISLANDS IN THE RESPIRATORY EPITHELIUM

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Does ciliary action have anything to do with bronchogenic carcinoma? This possibility has not been explored, as far as I know.

Carcinoma of the skin may be produced in some experimental animals by applying tar to the same spot at frequent intervals (daily or several times a week) over a period of time which is equivalent to a third or a half of the animal's normal life-span. The tar must be concentrated and it must be applied to the same spot. If tar were applied in a similar manner to the tracheal or bronchial mucosa, it is conceivable that carcinoma might be similarly produced there. Apropos of the current discussion of the relation of cigarette smoking to carcinoma of the bronchi, would these experiments with tar on the skin be at all pertinent?

The total quantity of tar in the smoke is small. The previous experiments[1] indicated that it is deposited as the smoke is passed through the bronchial tree. But, as far as one can tell in the studies on tracheobronchial trees from freshly killed beef animals, it is not deposited in concentrated masses or at certain points, but rather in a diffuse, thin film. This film is laid down upon or in the mucous blanket which normally lines the tract. If it is similarly deposited in the bronchial tree of a smoker, one or both of two things must then occur—the tar film must either be absorbed or it must be removed with the mucous blanket. It certainly does not stay there and accumulate.

There is no doubt that some chemical products from the smoke are absorbed, as indicated, for instance, by observable response of the

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small blood vessels to the smoking of a single cigarette. But, it does not seem likely that all or most of the smoke deposit is absorbed. Tar is almost insoluble and dissolves very slowly. It is likely that it is removed with the mucous blanket through ciliary action. This blanket, in the nose, is exchanged two or three times an hour.[2] Presumably the rate of exchange in the bronchial tree is of the same order of magnitude. In any case, these conditions would be very materially different from those of the experiment of producing skin cancer by application of concentrated tar.

REVIEW OF CILIARY DRAINAGE

The ciliary mechanism, constituted by the ciliary respiratory cells and the overlying mucous blanket, is not a newly discovered one; its essential features have been known for a century, but there has been a revival of interest in it during the past twenty-five years.[3-12] It actually constitutes a vital organ, upon the proper functioning of which, our very lives depend. The distressing symptoms of asthma, acute laryngotracheobronchitis, and war gas burns of the bronchial tree are essentially signs of ciliary insufficiency. The ciliary mechanism seems to play the leading role in postoperative atelectasis, in which instance, by the way, there is no insufficiency.[13] Perhaps it plays a large role also in bronchogenic carcinoma; as far as I have been able to determine from the literature, this possibility has not been considered.*

Let us review a few points of the physiology of this mechanism briefly. Mucous drainage by means of ciliary streaming in the upper respiratory tract is generally down and back toward the pharynx—thence on and into the esophagus and stomach. The mucous blanket covering the ciliated areas moves along at 5 to 10 mm a minute. Where the impact of inflowing air is considerable, there are fewer cilia and the flow is not so rapid; where there is little impact, as in the inferior and middle meatuses, protected by the turbinates, there are more and better cilia and the flow is faster. The direction of streaming on the medial face of the turbinates, past which the greatest flow of air takes place, is back, down and lateraly across the inferior margin and into the corresponding meatus. Presumably ciliary streaming on the turbinates takes this course because the mucous blanket, which is continuous, is dragged toward the area of greatest ciliary activity, in this case in the meatus—just as a fishnet, pulled through the water hand over hand by a line of men, would tend to travel toward those who pulled the fastest.

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*A search of subject matter in the Cumulative Index Medicus for 1921-22 and 1927-1953 failed to reveal any titles which implied that this subject was contained in any publication.

Where the impact of inspired air is very great,[2,14] as in the anterior third of the nose, there are no cilia and the epithelium, instead of being ciliated columnar, is a squamous-like or transitional type. This same type of epithelium is also found on the anterior, exposed surfaces of nasal polypi and septal ridges and spurs.

Some of this squamous epithelium in the respiratory tract is predetermined before birth, for instance, on the vocal cords and the preturbinal area in the nose. But, studies in which air-flow through the nose was altered by closing one nostril in experimental animals,[15] indicate that the distribution of this squamous-like epithelium can be altered or extended by changing its exposure to the impact of the incoming air.

The mucous membrane of the inactive, nonciliated anterior third of the nose, to inspection, appears essentially the same as the ciliated areas lying farther posteriorly. But, when the rate of mucous drainage is compared, there is a great difference. In some measurements made years ago,[2] it was found that the rate of flow in the anterior third of the nose was of the order of 1 to 2 mm per hour, whereas farther back over the ciliated areas it stepped up to 5 to 10 mm per minute, a velocity differential of 1:300. The drainage from the nonciliated areas, even though very slow, seemed to be complete; it just took much longer. The mechanics of drainage seemed to be a matter of simply dragging the mucous blanket backward, by virtue of its tensile strength, through ciliary action in adjacent areas. Although dimensionally thin, the mucus was viscid and would sustain a degree of traction.

In general, it may be said that those areas in the nose which are exposed to much impact from inspired air, either by direct flow or by means of eddies, tend to become nonciliated and the epithelium is found to be a squamous or transitional type rather than columnar.

Another important characteristic of ciliary drainage is its behavior where it encounters a cessation of ciliary action. A mere interruption in ciliary activity acts like a dam, even though no barrier is present. Some experiments were done a number of years ago on the maxillary sinuses of rabbits in an attempt to explain the failure of some of our clinical sinus surgery.[16] Many infected sinuses failed to recover even when a large surgical window, made for drainage purposes, remained widely patent. Surgical windows made between the sinus and the nasal cavity in these experimental animals invariably remained widely patent but still would not drain normal mucus, nor abnormal mucus either, unless present in large quantities. It was found that the direction of ciliary streaming was not materially al-

tered by the presence of such windows. The mucous blanket would not flow out the window to join that in the nasal cavity. Where the normal direction of flow was away from the window, the blanket moved on to the normal ostium and that portion of the sinus remained clean. When the flow was directed toward the widely open artificial window, the mucus gathered at the margin of the window, as at a barrier (and that portion of the sinus which was tributary usually became infected). Even though there was no apparent obstruction, the mucus would no more cross the line where ciliary action was interrupted than union workers would cross a picket line. Ciliary action is somewhat like that of an escalator. If someone stood at the bottom of a rising escalator, placing a box on each step, the boxes would stop and gather at the top. No obstruction would be necessary other than the boxes reaching the end of the escalator.

Mucous drainage from the lower respiratory tract is also accomplished by ciliary activity and is directed, in man, vertically upward to the larynx, whence it enters the lower pharynx to be passed into the esophagus. I have not measured the rate of flow in man but have done so in the bronchial tree of beef animals very soon after death. The rate was found to vary between individuals from 0 up to 36 mm per minute. It may vary in various parts of the same trachea or it may be fairly uniform everywhere in a single trachea. Stomach contents were recognizable in the trachea not infrequently in these specimens and probably represented an agonal phenomenon. The presence of stomach contents might account for some of the variations found since acid tends to suppress or stop ciliary action.

The lower respiratory tract is more completely lined by ciliated cells than the upper. The cilia in man extend from the cords downward as far as the respiratory bronchioles of 0.2 to 0.3 mm in diameter.

There are no large nonciliated areas below the vocal cords comparable to those in the upper tract, but there are islands of squamous epithelium or metaplasia devoid of cilia. These islands have been known since the last century. Why they occur has not been explained, neither is it known if they are present at birth or if they develop in postnatal life from impact of inspired air or other causes. They have been found in as many as 32 per cent of adults in one series[17] and may possibly be present in everyone. Many have described and studied them but no statements as to size or occurrence in animals were found in the literature.

Such nonciliated islands would inevitably have an influence on the rate of ciliary streaming at the points where they occur unless the ciliary mechanism functions essentially differently in the lower

than in the upper tract and there seems to be no indication of this. The effect would be to reduce the velocity of ciliary streaming and the degree of slowing would depend upon the size of the spot and how successful the surrounding cilia were in dragging the mucous blanket across or around it.

EXPERIMENTS

Effects of Deciliated Islands. Some experiments were done in order to explore the effects of such nonciliated islands.

Material. The trachea, bronchial tree and lungs from freshly killed cows were obtained from time to time on the killing floor at a packing plant and transported at once to the laboratory in a moist, warm box so that upon arrival at the laboratory the cilia were generally active.

Experiment 1. Ciliary Streaming, India Ink and Deciliated Islands. Tracheas cut from such specimens were used in this experiment, and the experiment repeated, with minor variations, fifteen times on thirteen tracheas. Each trachea was laid upon a board with the anterior aspect downward; it was opened posteriorly, either through a window large enough to permit of manipulations within or was split wide open and nailed out upon the board. Small areas in each were deprived of cilia. In some cases, a small bit of gauze held in a mosquito forceps was wiped across an area 5-6 mm long and half as wide. In others, the end of a very tiny cotton swab, 2.5 mm in diameter, was rested gently against a spot in the mucosa and rotated a few times. In still others, a small dental burr, held in the fingers, was rotated gently against the mucosa in order to create a perfectly round spot devoid of cilia. All of these methods produced deciliated islands from which the surface ciliated cells were removed or destroyed and only the deeper replacement cells remained. This was demonstrated histologically and by observation of the living ciliated cells in situ.

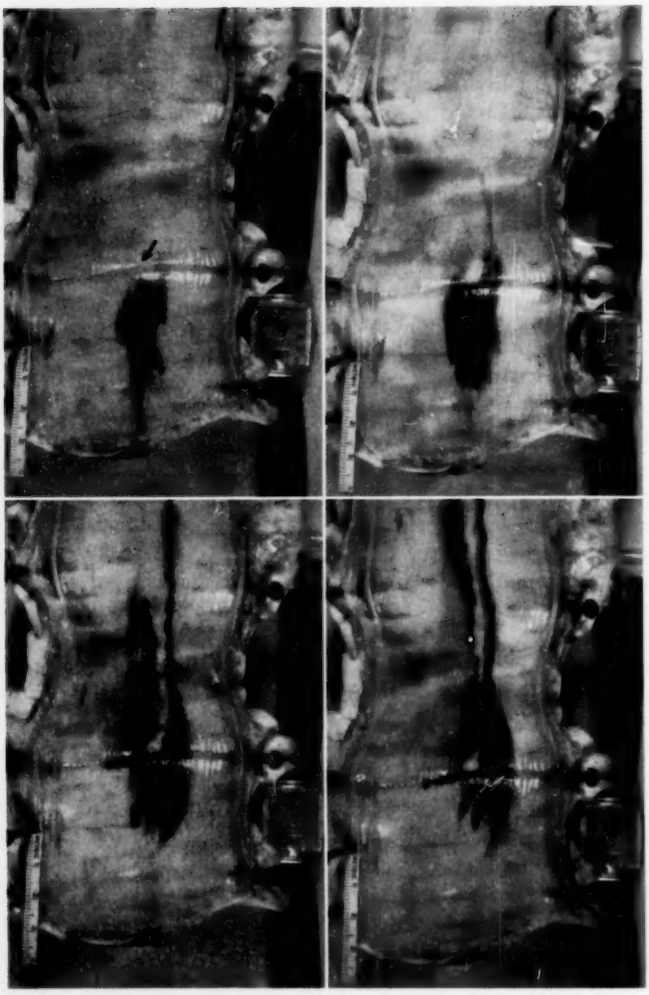
The ciliary streaming of the mucous blanket was made grossly visible and observable by means of droplets of India ink placed upon the surface upstream (caudad) from the deciliated islands.

Results. Between 30 and 35 deciliated islands were thus prepared. Ink collected upon all but four. The ink spread somewhat immediately upon application and then was carried as an extending film, upon and within the flowing mucous blanket, toward the laryngeal end of the trachea. When the film reached a deciliated island, the ink would stop—hang up, as it were—and accumulate across the spot in the form of a black crescent (Fig. 1). The action was like

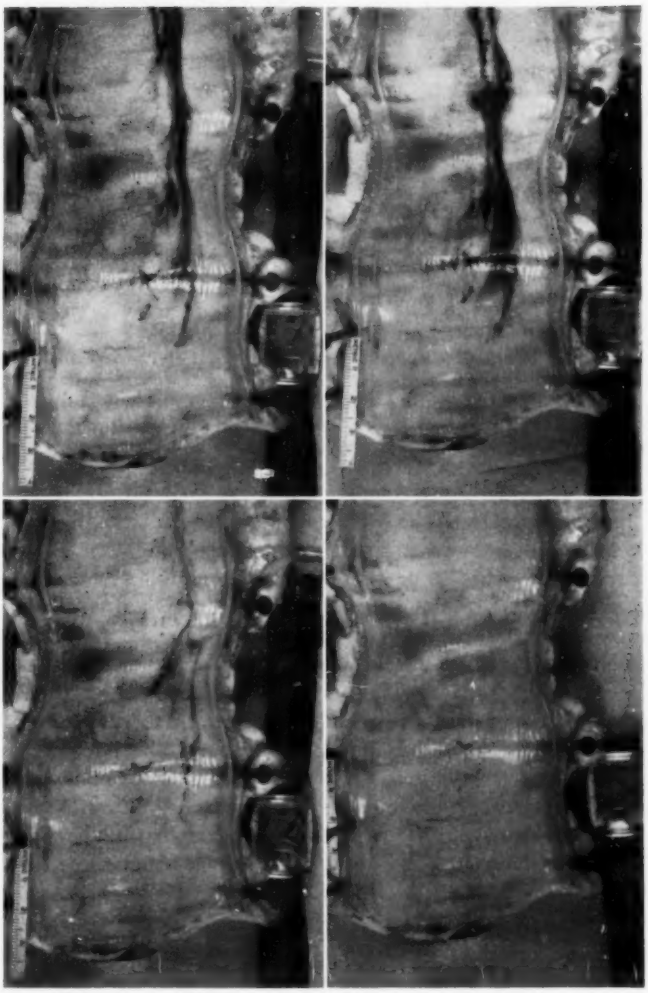
that of a scum on a stagnant pond driven by a gentle breeze against reeds or sticks fastened to the bottom and extending above the surface. Over most of the tracheal surface, when the ink had been traveling for some distance, it would spread out thinly, sometimes becoming almost invisible but, at the islands, it accumulated in dense black crescents. It was noted, however, that the ink tended to flow to one or both sides of the island, like a stream of water flowing around and past an obstruction. Some of these specimens were observed for several hours, starting new ink films repeatedly. Eventually, the ink would all accumulate at the upper end of the trachea and the lining would appear clean except at the deciliated islands where it usually remained for the duration of the experiment (Fig. 1).

The condition at such an island was not quite comparable to a natural island of metaplasia in that the latter is presumably covered with the mucous blanket, whereas in some of the artificial ones the continuity of the mucous blanket was broken. In order to make the two more nearly similar, the artificial islands in some specimens were again covered with mucus. This was accomplished by picking up with a forceps masses of mucus which had accumulated at the laryngeal end of the trachea and dropping them upon the mucous surface upstream from the deciliated island. This mucus was viscid and tenacious and tended to retain a rounded, elevated form when dropped upon the mucous membrane. It moved along well by ciliary action. As it approached the island, it would slide past on either one side or the other, unless it had been carefully and accurately placed so as to impinge squarely upon the island. When so placed it would become indented in the middle of the leading edge and take on a bean-like form, about 1 cm upstream from the island, as though the traction in the middle had weakened or ceased, whereas that upon the outer borders continued to be strong. The velocity of the whole mass then became reduced but progress did not cease. The leading edge and leading surface were pulled under the main mass as this was partly dragged and partly rolled across the island. When it was once over the spot, the mucous mass continued on its way to the laryngeal end of the trachea and the deciliated island was usually once more covered with mucus. The experiment with the ink was then repeated with essentially the same results excepting that the ink crescent did not seem to be quite so large or dense and it was more readily dragged away by adjacent ciliary action.

Experiment 2. Ciliary Streaming, Cigarette Tar and Deciliated Islands. The object of this second experiment was to determine the action of deposited smoke tar about deciliated islands. The tracheobronchial tree and lungs from calves were used. The lower third of



Figs. 1 and 2.—Series of photographs illustrating ciliary streaming about a deciliated island in the trachea of a freshly killed cow. Streaming was made visible by means of a drop of India ink placed upstream (caudad) from a deciliated island. The photographs were taken from 1 to 90 minutes after the application of the ink. The deciliated island is indicated by the arrow.



Just upstream from this island, there is another line-like area of stasis of about the same size. This could be spontaneous but more likely was produced accidentally during handling of the specimen. (There is a fold across the trachea just at the deciliated island. This was inadvertently caused by the nail appearing just above the watch and has no relevance to this study.)

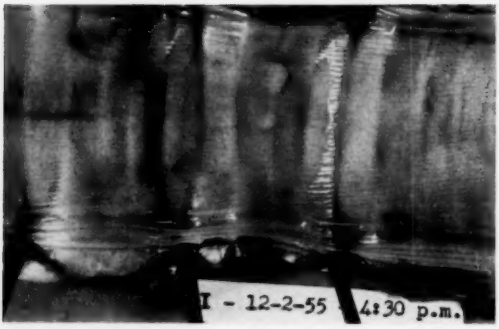


Fig. 3.—Trachea from Calf 17 as it appeared 3 hours and 20 minutes after 20 mm of cigarette had been smoked through it at a pressure of 45 mm of water. There was a faint yellow film over all surfaces, appearing gray in the photograph, and there were two crescents of tar-containing mucus marking two of the deciliated islands. The third island made in this region does not appear, neither did those made in the primary bronchus.

each lung was removed, the trachea attached to the smoking apparatus and a measured amount of cigarette smoked through the preparation at a pressure of either 40 or 45 mm of water (Table I). Immediately after the smoke had been passed, an opening was made along the posterior raphe in the midtrachea and a second at the bifurcation. Through these windows, small spots of mucosa were deciliated as in the previous experiment. The experiment was done six times on as many lung preparations. In each instance, three deciliated islands were prepared in the midtrachea, one anteriorly and one each on the right and left lateral walls. Islands were made in each main bronchus, varying in number from one to three. After the islands had been prepared, the specimens were returned to the warm box, where three were left for about an hour and a half and the other three for about twice as long before being observed.

Results. In all, 39 deciliated islands were prepared in the six trachea-lung preparations. When observed at the end of the experiment, five islands were marked by small masses of tar-containing mucus. Two of these were in the trachea and both in the same specimen (Fig. 2). The other three were in the main bronchi, two of them in one specimen. In two other specimens, there were small masses of mucus which may have collected because of the deciliated islands, but one could not be sure (Table I). The two accumulations in the one trachea were especially striking because they took the form of sharp crescents and resembled the ink crescents so closely (Fig. 2).

TABLE I.

OUTLINE OF DATA AND OBSERVATIONS MADE ON SIX ANIMAL SPECIMENS STUDIED TO DETERMINE THE ACTION OF DEPOSITED SMOKE TAR ABOUT DECILIATED ISLANDS

CALF NO.	MM. OF CIGARETTE	PRESSURE IN MM H_2O	DECILIATED ISLANDS TRACHEA	DECILIATED ISLANDS BRONCHI RT.	DECILIATED ISLANDS BRONCHI LFT.	TIME WHEN SPECIMEN WAS OBSERVED	RESULT
7	5	40	3	1	1	1 hr. 36 min. (96 min.)	Tar-containing mucus collected at cut end (laryngeal) of trachea. No collection upon any of the islands.
8	10	40	3	1	1	1 hr. 40 min. (100 min.)	Tar-containing mucus collected at cut end of trachea. A mass of tar-containing mucus on the island in the right main bronchus.
19	10	45	3	3	3	3 hrs. 30 min. (210 min.)	Tar-containing mucus found ringing the cut end of the trachea. None of the 9 islands clearly marked altho there were 2 small blobs of tar-containing mucus in the left main bronchus at or near one of the islands.
9	20	40	3	1	2	1 hr. 35 min. (95 min.)	Tar-containing mucus collected at cut end of trachea. Small crescent of stasis upon each of the two islands in the left bronchus.
17	20	45	3	2	2	3 hrs. 20 min. (200 min.)	Faint yellow film in upper half of trachea. Two islands in trachea well marked by tar-containing crescents of mucus—one on anterior surface and one on right lateral.
18	20	45	3	2	2	3 hrs. (180 min.)	Irregular line of accumulated mucus containing tar and blood lying across upper trachea, varying in position between 20 and 40 mm from the cut end. Stasis above this line. Faintly yellow above and for a short distance below this mucus. None of the islands identified.

COMMENT

These experiments indicate the effect of deciliated spots upon the mucous streaming over an otherwise well ciliated epithelial surface. As one would expect, interference with the flow of the mucous blanket occurs at the deciliated spot. Simple physics would predict such a result, as would previous observations of the nonciliated areas of the nose and ciliary streaming over and about these areas. This interference may be manifested in several ways: by a mere pause, by change of direction or by actual stasis with accumulation.

When a droplet of India ink is placed upon the tracheal mucosa upstream from a deciliated island, it tends to flow to either one side or the other by ciliary streaming. If it straddles the island, then that portion directly upstream from the island tends to decelerate its rate of flow some millimeters above the island. When it reaches the island, it stops flowing and is pushed upon the upper side of the island, by ciliary action, where it forms a crescent. If the film of ink is long in the axis of flow, a considerable amount may accumulate here. If ciliary action continues and no more ink is added, the surrounding areas will cleanse themselves of ink completely. But, at the deciliated island, a crescent will remain. It remains for several reasons, among which are these: lack of cilia to move it, the presence of a small, shallow saucer of damage into which some of the ink is pushed and, in some instances, because of a dehiscence in the mucous blanket. If allowed to remain long enough, the surrounding cilia will eventually remove it by continuing to drag the mucous blanket over it. Thirty to thirty-five deciliated islands were tested in this experiment and ink accumulated upon all but four of them.

To be sure, India ink is not cigarette tar and a deciliated island is not the same as a squamous island. Therefore, one must make comparisons with reservations and draw conclusions with caution.

In the second experiment, smoke was passed through the trachea-lung preparations from recently killed calves. The smoke products were deposited in thin films upon the lining mucous blanket. Some of these smoke products are readily soluble and are toxic to the ciliated cells. If these toxins are sufficiently concentrated, ciliary action ceases. This was not the case in the six specimens used in this experiment. There was a ring of tar at the laryngeal (cut) end of the trachea in four, showing that the mucous membrane in the tract had cleaned itself by ciliary action. In the other two, the tar had been carried into the upper trachea and only the lower portion cleaned.

Thirty-nine deciliated islands were prepared in these six specimens and a mass of tar-laden mucus had accumulated upon five of

them when the preparations were removed from the warm box at the end of the observation period. If tar had collected upon any of the others, it was cleaned away before the specimen was examined. The latter is a possibility since the time in the warm box was an hour and a half or longer. Be that as it may, in the conditions of these experiments, most of the islands did not show accumulations of tar. It seems likely that the ciliary mechanism maneuvers the mucous blanket in such a way that it slides by or over the deciliated spots without leaving deposits. In those instances where tar did accumulate, it was apparently pushed upon the deciliated spots by ciliary action and left there.[1]

Ciliary streaming in both of these sets of experiments was slowed down at the deciliated spots so that it took hours instead of minutes to clean them. This has some very important connotations as far as cigarette smoke is concerned.

The smoke is deposited in a thin, rather even film upon all exposed mucous surfaces. Those compounds which are readily soluble are quickly dissolved in the mucous blanket and may quickly act upon the local cells or be absorbed. Such action would be widespread and the concentration of the chemical compounds probably would be much the same everywhere.

With relatively insoluble or slowly soluble compounds, the story would be quite different. They might be removed from the tract entirely by ciliary action before there was time for them to dissolve and before any appreciable effect had been made upon the mucosal cells, unless the mucous blanket should "hang up" at some point. If an accumulation of mucus and tar should occur upon islands of squamous epithelium devoid of cilia, as it did upon these artificially deciliated islands, then the action of slowly soluble chemical compounds upon the cells over which the accumulation occurs might be greatly increased.

Several factors would contribute to this increase: 1) There would be a materially extended time for the slowly soluble compounds to go into solution. 2) The concentration of the solution would be greater than elsewhere in the mucous blanket. 3) The time during which the cells are exposed to the action of these compounds would be increased inversely as the rate of flow is decreased. 4) Compared to elsewhere in the blanket, great quantities of these compounds would accumulate and be made available for action upon the cells.

Cigarette tar is a mixture of compounds, many of which are classified as insoluble or slowly soluble. Many of the known carcino-

gens are "insoluble" in water—such as benzpyrine, methylcholanthracene, benzanthracene, B-naphthylamine, N-monomethy-N-dimethyl-2-aminofluorene. As a matter of fact, all are slightly soluble in water and one would suppose that they would have to be in solution in order to affect the cells. If such materials in cigarette tar should accumulate and remain upon one spot, even for half an hour, the possibility of increased action upon the underlying cells is enormous. If the smoker smokes a cigarette every half hour, that spot might not be free of concentrated tar all day, from the time he lights his morning cigarette in the bathroom until he has retired at night. The concentrated tar would be applied accurately and intimately to the same cells day after day and week after week and year after year, as long as he smokes (unless the squamous spot should shift position). This might be for 20, 30 or 40 years—easily a third to a half the life-time of the individual. Under these circumstances, the conditions of the production of experimental cancers on the skin by means of tar would be closely duplicated. It would seem that these experiments of tar cancer of the skin are pertinent to the discussion of carcinogenesis in the bronchial tree from cigarette smoking after all. The thought which I had in the beginning of these studies, and which has undoubtedly been entertained by others, that tar might be deposited in quantity sufficient for carcinogenesis at points of impact by inflowing air during inspiration, seems much less likely in the light of these findings.

It is not to be supposed that every tiny nonciliated spot would cause an accumulation. The majority probably would not. In most instances, the mucous blanket probably would slide over or around fairly readily. Unusual local conditions of ciliary streaming would probably be necessary. Study on this matter is continuing and will be reported in a subsequent paper.

CONCLUSIONS

1. The mucous blanket in the tracheobronchial tree, when made observable by India ink, may be made to impinge upon and accumulate at an artificially deciliated island as upon an obstruction. It may remain for a matter of hours upon such a spot while ciliary action and streaming of mucus continues in surrounding areas.

2. Accumulations of cigarette tar may be similarly produced by smoking 10 or 20 mm of cigarette into the trachea at a comparatively low pressure.

3. If the slowing or interruption of normal ciliary streaming at nonciliated islands in the tracheobronchial trees of smokers is at

all comparable to that occurring at the artificially deciliated islands, then the resulting accumulations of concentrated tar at isolated spots would duplicate closely the conditions of the experiments of carcinogenesis on the skin by means of tar. There lies the crux of the matter —are there such accumulations on naturally-occurring squamous islands? From other data, this would seem to be probable. These experiments, taken alone, are suggestive, but do not demonstrate it.

4. This process of piling up of noxious material upon nonciliated islands by ciliary action during normal ciliary drainage, rather than a deposit during inspiration, either from direct impact or because of eddies in air flow, could be the key to carcinogenesis in the bronchial tree from any inhaled carcinogenic substance of whatever nature.

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Grateful acknowledgment is made to the Elliott Packing Company of Duluth for their co-operation in furnishing the material upon which the experimental studies were made.

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XIII

THE SURGERY OF CANCER OF THE LARYNX

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Once having established the histologic diagnosis of cancer of the larynx, the laryngologist is then confronted with a series of perplexing problems: he must further determine the apparent gross extent of the tumor as accurately as possible, define it as suitable for resection, or not; and select the proper surgical method for its removal. The making of these determinations is greatly facilitated through a consideration of the following criteria.[1]

1. Location and extent of growth.
2. Presence or absence of impairment of motility.
3. Presence or absence of metastases, local or remote.
4. Grading according to Broders' classification.
5. General condition of the patient.

The propriety and importance of such an evaluation is indisputable, for it is obvious that failure in this appraisal necessarily will result in failure of the entire effort. Of equal importance, it might be added, is the need for objectivity in making this evaluation, implicitly appreciating the malignant nature of this disease, and holding as self-evident that whenever untreated or mistreated, it will cause death of the host.

The various surgical techniques commonly employed in the treatment of laryngeal cancer, to borrow a modern phrase, have been functionally designed: designed to cope with a type of tumor, classified according to location, extent, and grading, and whether or not complicated with regional metastases. Classifying the tumor, in no sense precludes this surgery to be stereotyped or static, for conversely, modifications and extenuations of each basic technique are constantly being devised in attempts to better and more surely eradicate these malignant growths, and are being employed successfully in many instances.

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From the Department of Laryngology and Bronchoesophagology, Jefferson Hospital, Philadelphia.

Failures in the surgical management of cancer of the larynx are due to an inadequacy of the primary operation. This inadequacy usually reflects on the improper selection of operation, but it must also be realized that many such failures are accountable to the presence of an undetected or undetectable microscopic metastases at the time of operation. In view of this thought, the development of regional metastases postoperatively in no way voids the rationale of appraising the criteria that characterizes a tumor, nor does it nullify an operation well performed and presumably properly selected.

EVALUATION OF OPERATIVE FAILURES

1. RESECTION OF THE CORD

Cordal resection, most commonly effected by means of thyrotomy, or laryngofissure, is the elected surgical procedure utilized in instances wherein the carcinoma is so situated as to be entirely contained on the anterior or middle thirds of the vocal cord, without involvement of the anterior commissure or extension to the opposite cord, without subglottic extension or extension into the ventricle, and without any evidence of impairment of motility. The management of lesions conforming to this definition poses no problem. Resection of the involved vocal cord should be tantamount to cure.

Recurrence rates following the laryngofissure operation for cancer of the larynx, reported in large series of cases, vary from 13 to 25 per cent.[1-3] In view of the fact that this surgical technique is primarily intended for the resection of localized cordal growths, as defined above, the magnitude of these statistics indicates a disproportionate number of failures. Local laryngeal recurrences indicate incomplete removal of the tumor at the time of primary thyrotomy; and accepting the operator's ability to perform a valid procedure technically, it must be concluded that the principal inadequacy responsible for local recurrences following thyrotomy is the improper selection of operation.

In a certain number of instances one sees malignant cordal growths that fail to conform to the ideal, but in which it is assumed that resection can be accomplished by means of the laryngofissure technique. The practice of extending this technique to accommodate such lesions is a truly hazardous one, for its accounts for the greatest number of failures, and not only jeopardizes its standing and the reputation of the surgeon, but jeopardizes the life of the patient as well. Statistical proof of this lies in the fact that remote or organ metastases account for four to ten per cent of deaths following laryngofissure failures,[1,3] metastases that possibly could have

been avoided had the surgeon not elected to have a "boy do a man's job."

The following salient statistics substantiate these thoughts. In reviewing 371 cases of cancer of the larynx operated on by the technique of laryngofissure, that could be traced for a period of five or more years after operation, it is noted that there were recurrences in 73, or 19.7 per cent of patients. Thirty-seven, or 50.6 per cent of these, were salvaged by means of various secondary surgical procedures, and have lived free of cancer for more than five years.

These recurrences were found locally in the larynx in 51 instances, as regional lymph node metastases in 12, and in 10 as remote metastases. Of the 51 instances of local recurrence, 6 were operated upon by revision laryngofissure, 38 by means of total laryngectomy, and 7 were treated by irradiation. Six of the irradiated patients died of cancer, one is living seven years postoperatively although still with evidence of residual cancer. Fourteen of the 38 patients operated upon by laryngectomy are dead of cancer, 24 are living five or more years after laryngectomy. Of the six cases of revision thyrotomy, all are living and well more that five years postoperatively. In the group of 12 with metastases to regional lymph nodes radical neck dissections were performed in 11; 7 are living and well, five years after this operation; all of the others are dead of cancer.

Additional criticism pertaining to the causes of the local laryngeal recurrences is particularly pertinent to this review. Further study of the records of these 51 patients reveals that there was evidence at operation of extension of tumor to either the anterior commissure or to the opposite vocal cord in 32 cases, of subglottic extension in 14, and of lateral extension of the cancer into the ventricle in 5 cases. These 51 instances of local laryngeal recurrence then, were directly, although not deliberately, attributable to having selected thyrotomy improperly, or to an attempt to extend the technique of thyrotomy to accommodate lesions that had grown beyond the confines of one vocal cord.

Comment. Laryngofissure is a highly effective surgical method for the resection of malignant tumors entirely contained on the vocal cord. And although the technique of laryngofissure has been utilized successfully in many instances in resecting larger or more extensive lesions, this practice is also responsible for the greatest number of local recurrences following thyrotomy.

It is important to realize, too, that to withhold more radical surgery as reserve procedures, in event of recurrence following thyrot-

omy, is not justifiable. Many instances of regional metastases, together with the remote metastases, have had their fates determined long before such metastases were demonstrable.

2. LARYNGECTOMY

Cordal growths which fail to conform to the definition stated as acceptable for thyrotomy, and lesions originating on the epiglottis, the subglottic area, or the aryepiglottic fold, but without evidence of either extension to the lateral pharyngeal wall, or to the base of the tongue, or of regional or remote metastases, are suitably selected for primary total laryngectomy.

Failures following primary laryngectomy, usually noted as regional lymph node metastases, are currently reported as occurring in from 20 to 30 per cent of cases.[4,5] The reason for the higher incidence of failures following laryngectomy, as contrasted to thyrotomy, is readily apparent when one realizes that with more extensive lesions necessitating more radical primary surgery, the more likely it is that metastases to regional nodes are present but undetectable at the time of initial operation. The detectable presence of palpable cervical lymph nodes, either in instances of proven cancer of the larynx, or following operation on the larynx for cancer, constitutes presumptive evidence of malignant metastases.

The material for this review consists of three groups of patients. First, there are 351 cases of laryngeal cancer, that could be traced for a period of five or more years after operation, and which were operated by means of total laryngectomy. This group includes patients with all varieties of cancer of the larynx; extrinsic as well as intrinsic, epiglottic and postcricoid lesions, and tumors extending into the pyriform sinus. In common, they were adjudged to have no evidence of metastases preoperatively. Following laryngectomy, metastases, either cervical or remote, eventually developed in 113 patients (32.1 per cent). Only 69 of these failures were suitably selected for secondary radical neck dissection, of whom 36 are living and well five or more years after this secondary surgery. This represents a surgical salvage rate of a little better than 50 per cent, but a total salvage rate of only 31.8 per cent. One additional case survived for more than five years following irradiation therapy. Seventy-six patients are dead of cancer.

The second group consists of 18 patients who, at the time of initial examination, were found to have demonstrable cervical metastases complicating their laryngeal cancer. Prior to 15 years ago, the presence of such metastases rendered these patients inoperable, and

consequently they were referred for irradiation therapy. With but few exceptions such situations quickly eventuated in death. Originating with such a group, the technique of one stage laryngectomy with radical neck dissection was begun, somewhat out of despair, but truly actuated by a surgical principle utilized successfully in other fields of cancer surgery. Eight of the original 18 patients are living and free of metastases for more than five years. Projected statistics based on cases operated since 1950 indicate that this rate will increase substantially as time goes on. So, although only in minimal numbers, this technique has demonstrated its potential ability to effect cure of "inoperable" cancer.

The third group consists of 17 patients with cancer of the larynx, with impalpable cervical lymph nodes, but who, either because of the gross extent of the tumor, or because of its location, were operated by means of elective one-stage laryngectomy with radical neck dissection. The election to perform such an extensive surgical procedure is founded on the experience gained from analyzing the above mentioned failures. Cervical metastases are more prone to develop in carcinomas originating outside of, or extending beyond, the true vocal cords. All of the 17 patients so operated are alive and well five or more years following operation. Of particular significance is the fact that carcinoma cells were found in the resected cervical lymph nodes in six of these patients.

Comment. Although laryngectomy is technically an adequate surgical procedure for the resection of malignancies contained within the larynx, the relatively high incidence of postoperative metastases (20-30 per cent) indicates its inadequacy. This same inadequacy signifies the need and rationale for the technique of one-stage laryngectomy with radical neck dissection. This technique is positively indicated where cervical nodes are palpable at the time of initial operation, and relatively indicated, where, either because of the extent or position of the carcinoma, one suspects the presence of, or anticipates the early development of cervical metastases. Lesions of subglottic or supraglottic origin, and cordal lesions with subglottic extension or arytenoid fixation, are ideally suited to this elective surgical method. It is only by accepting this combined procedure as a primary operative technique that the incidence of metastases following surgery for cancer of the larynx will be reduced.

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XIV

INDICATIONS FOR RADICAL SURGERY, PARTIAL SURGERY, RADIOTHERAPY AND COMBINED SURGERY AND RADIOTHERAPY FOR CANCER OF THE LARYNX AND HYPOPHARYNX

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Cancer of the larynx and hypopharynx may be treated either by surgery or radiotherapy alone, or in combination with each other. Though adequate resection of the cancer is imperative, it is often possible to accomplish this by partial laryngeal surgery, thus preserving some laryngeal function and permitting the patient to remain an active member of society.

About 800 patients with cancer of the larynx and hypopharynx have been operated on during the past 18 years at the Curie Foundation. Of these, 350 were operated on more than five years ago, some also receiving radiotherapy. Survival statistics on 525 patients with cancer of the pyriform sinus, treated solely by radiotherapy and 13 in whom this therapy was combined with surgery, were analyzed with Ennuyer; they had been irradiated at the Curie Foundation from 1921 to 1946.

On the basis of the above material, we have attempted to postulate therapeutic indications for the different anatomic varieties of cancer of the larynx and hypopharynx, trying to determine in which locations to recommend radiotherapy or surgery alone, or in combination with each other, and if both are used, their sequence; also modifications of these procedures in the presence of clinically metastatic lymphadenopathy. As a result of this study we have arrived at the following conclusions:

COMMON ERRORS TO BE AVOIDED IN THE CHOICE OF THERAPY

1. *Inadequate surgery.* This leads to rapid recurrence, e.g., a hemilaryngectomy for vestibular cancer; a thyrotomy when done, where a frontal, frontolateral or hemilaryngectomy is indicated.

Presented at meetings of the Departments of Radiology and Otolaryngology at the Presbyterian Hospital, Columbia University Medical Center, the Manhattan Eye, Ear and Throat Hospital, and the Memorial Hospital, in New York, in February 1954.

2. *Excessive surgery.* Total laryngectomy when partial laryngectomy suffices to remove the cancer, yet preserves partial function of the larynx.

3. *Failure to obtain early surgical evaluation.* Many cases are sent directly to the radiotherapist when surgery may actually be the treatment of choice.

FACTORS WHICH INFLUENCE THE CHOICE OF THERAPY

(Such procedures as emergency tracheotomy are excluded from consideration.)

1. *Location and extent of the lesion*

2. (a) *Microscopic character* of the lesion: differentiation may be accompanied with increased radioresistance.

(b) *Macroscopic appearance.* Exophytic growths not immobilizing any portion of the larynx are more likely to be radiosensitive than those which infiltrate, ulcerate or fix laryngeal structures.

3. *Clinically metastatic lymphadenopathy.* This may modify the plan of therapy.

4. *Age and general condition of the patient.* Major laryngeal surgery in patients above 70 years old may be risky; yet laryngectomy in a patient 72, and a thyrotomy in one 80 years old, was performed successfully by us.

5. *Pulmonary tuberculosis.* This was an absolute contraindication to surgery before the antibiotic era. Now, thanks to streptomycin, total laryngectomies have been performed successfully in cases of nonprogressive tuberculosis.

6. *Cardiac disease.* This is the most common contraindication to surgery.

7. *Total laryngectomy is frequently better tolerated than partial laryngectomy.* In the former the lower respiratory passages are completely excluded from the field of operation.

ANATOMIC CLASSIFICATION OF LARYNGEAL CANCER

1. Cancers of the larynx may originate in the region of the vocal cord, the laryngeal surface of the epiglottis, the ventricular band, the ventricle or the subglottis.

2. Cancer of the hypopharynx may arise on the floor of the pyriform sinus, its walls, the laryngeal margins and the posterior pharyngeal wall.

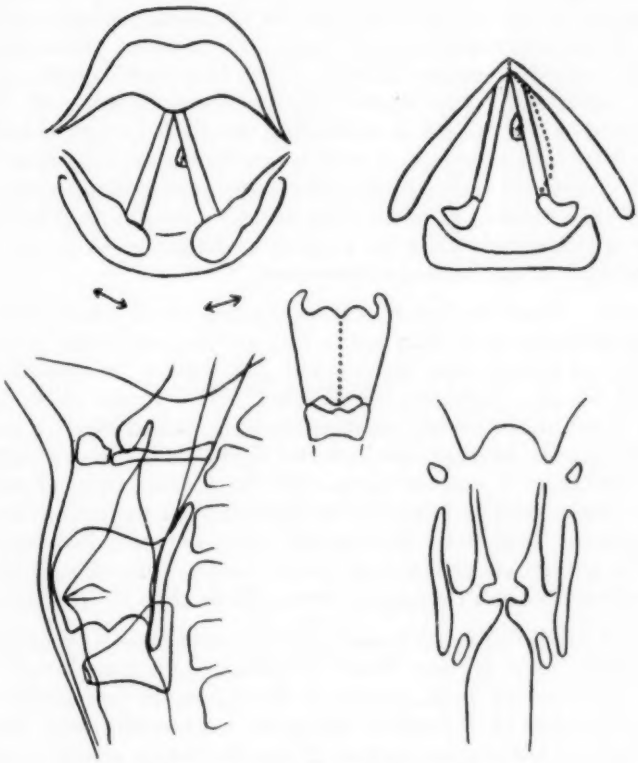


Fig. 1.—Indication for the thyro-fissure. Small growth localized in the middle third of a vocal cord freely movable.

THERAPEUTIC INDICATIONS IN LARYNGEAL CANCER WITHOUT CLINICAL LYMPH NODE METASTASES

1. *Vocal cord.* (a) When the disease is limited to a small area on the middle of the vocal cord with complete preservation of mobility of the cord, we advise simple thyrotomy and cordectomy, without post-operative radiotherapy; this should yield a five year cure of 100 per cent. There is practically no operative risk and healing occurs in eight to ten days. The functional result will be excellent if the anterior insertion of the opposite cord is left undisturbed. Impaired function due to formation of anterior synechia or a web will result if there is even the

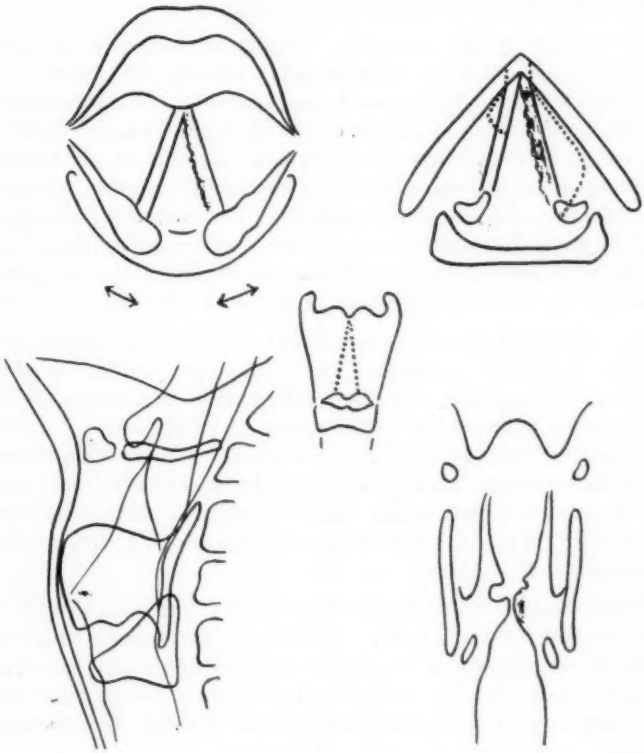
slightest damage to the opposite cord, near the anterior commissure during the operation. In these cases the therapeutic result is equally good if adequate radiotherapy is used. We, however, prefer surgery for the following reasons: Surgery results in a cure in eight to ten days; radiotherapy may require two months or longer. If radiotherapy does not succeed in eradicating the disease, a simple cordectomy is no longer possible; a total laryngectomy must be done, due to the changes in the cartilage and mucous membrane produced by x-ray. In addition, we believe that the radiotherapist must be much better qualified technically for treating cordal cancer by x-ray, than the surgeon for performing a thyrotomy.

(b) When the cancer, though limited to the vocal cord, involves the entire cord from end to end, yet the cord is still perfectly mobile, we believe, that surgery and radiotherapy are equally successful, usually resulting in a complete cure. If one elects to do surgery, which we prefer, for the reasons mentioned above, a partial (frontolateral) laryngectomy is better than a thyrotomy; postoperative irradiation is not necessary. The functional result, of course, cannot be as good as following thyrotomy; the anterior insertion of the opposite cord must be resected. Anterior synechial webbing usually results; nevertheless we prefer surgery to radiotherapy, as we believe that cure by surgery is more likely than by irradiation.

(c) When the entire vocal cord is involved and is either totally or partialy fixed, surgery should be preferred to radiotherapy; the more fixation, the more definite is the indication for surgery. A hemilaryngectomy is usually adequate; tracheotomy may not be necessary, unless a great portion of the thyroid or cricoid cartilage have been resected. The postoperative course is as uncomplicated as that of a frontolateral laryngectomy; the functional result is almost as good, from the point of view of phonation and respiration. This operation need not be followed by irradiation since invasion of the lymphatics is uncommon in these cases. The five year cure rate is usually about 70 per cent.

(d) Involvement of the vocal cord in the juxta-commissure region or if the commissure itself is invaded indicates surgery over radiotherapy, even more strongly. The operation we advise is a partial laryngectomy (fronto-anterior), of which the frontolateral laryngectomy is a modification.

2. *Subglottic cancer.* Cancer of the subglottic area causing fixation of the involved site of the larynx is essentially within the domain of the surgeon. Radiotherapy too often fails whereas the surgical cure rate is 60 per cent. No postoperative radiation is neces-



Unilaterality to be seen on side-face radiography and on tomography.
Not any extension of subglottic region.

Fig. 2.—Indication for the partial laryngectomy. The frontal lateral laryngectomy. Cancer of a vocal cord. Neoplasm of the whole cord of which the movement is not handicapped.

sary because of the low incidence of lymph node invasion in subglottic cancer. The type of surgery depends on the extent of the lesion. If the disease is bilateral, a total laryngectomy is required. If it is strictly unilateral an Hautant type of hemilaryngectomy is adequate and has yielded a 70 per cent five year cure rate. Bilateral involvement is most commonly found just beneath the anterior commissure; occasionally this occurs posteriorly in the precricoid region. Though bilateral invasion anteriorly does not markedly affect long term prognosis (provided the treatment is total laryngectomy) pos-

terior bilateral involvement gives a poor prognosis, even if complimentary radiotherapy is added to the surgery.

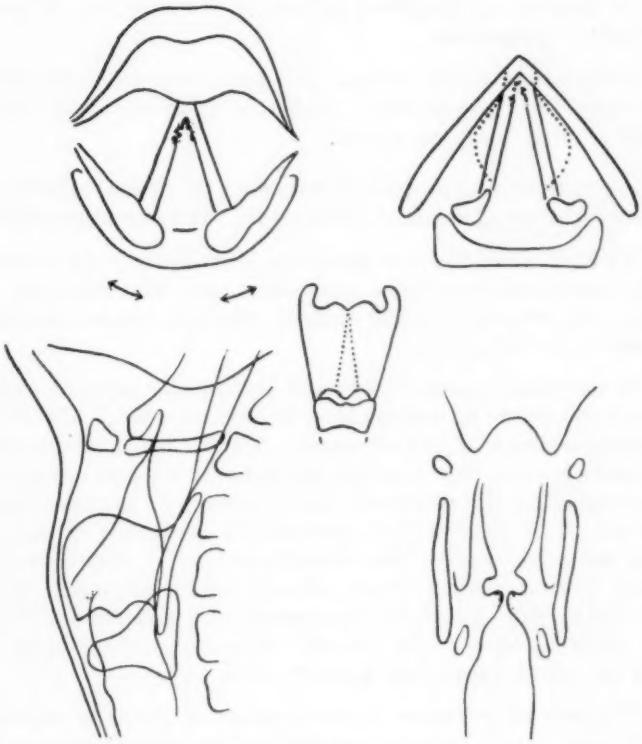
3. *Cancer of the ventricle.* Ventricular cancer is also better treated surgicaly than by radiotherapy. Usually the disease is advanced by the time it is diagnosed, and often there is involvement of the contiguous portion of the ala of the thyroid cartilage. Total and never partial laryngectomy should be done, because of the tendency of this cancer to become bilateral by extending into the ventricular band and across the base of the epiglottis. Postoperative radiotherapy should be given routinely if a cure seems at all possible. Total laryngectomy with postoperative radiotherapy in this group of cases in our hands has resulted in a 30 to 35 per cent five year cure rate.

4. *Cancer of the ventricular bands and laryngeal surface of the epiglottis (laryngeal vestibule).* (a) In cancer of the infrahyoid portion of the epiglottis, the best results have been obtained by total laryngectomy followed by a full course of radiotherapy. In some cases partial laryngectomy has been adequate. Surgery without radiotherapy, however, has usually failed; this has been due to silent metastases to cervical lymph nodes which manifested themselves several months after surgery. Radiotherapy has increased our five year cure rate to nearly 30 per cent.

Radiotherapy without preceding surgery has been equally successful in some of these cases. These have been lesions which were superficial, serpiginous or exophytic without significant impairment of mobility of the larynx, without invasion of the pre-epiglottic space (as evidenced in lateral radiographs), and without involvement of cartilage.

On the other hand, surgery has been found essential if the lesion was infiltrating deeply, ulcerating completely, fixing a portion of the larynx or significantly invading the pre-epiglottic space or cartilage. The type of laryngectomy for the particular case is selected as follows: A horizontal supraglottic laryngectomy may be done, sparing the vocal cords and permitting nearly normal phonation, providing that the posterior two-thirds of the ventricular bands and the arytenoids are not involved and are perfectly mobile. A supracricoid laryngectomy is done (sparing the cricoid which may be attached to the skin, thus simplifying postoperative care), if the posterior half of the bands and arytenoids, though not invaded, present a little impairment of mobility.

Total laryngectomy, followed by postoperative radiotherapy is imperative if the ventricular bands are invaded and one arytenoid is fixed.



Circumscribed invasion of subglottic region
to be seen on side-face radiography.

Bilaterality is shown on tomography.

Fig. 3.—Indication for the partial laryngectomy. Frontal anterior laryngectomy. Cancer of the anterior commissure of the vocal cords. The invasion of subglottic region is beginning.

(b) Cancer of suprahyoid portion of epiglottis. In lesions which are exophytic, pedunculated (which is exceptional) and not extending to the glosso-epiglottic fossae or the aryepiglottic or pharyngo-epiglottic folds, radiotherapy is preferable to epiglotectomy; the cure rate is better and surgery if done should be followed by radiotherapy.

In exophytic lesions which have extended to the glosso-epiglottic fossae or the aryepiglottic or pharyngo-epiglottic folds, radiotherapy still has much to offer when used alone. If surgery is used, this has

to be total laryngectomy, and must be followed by radiotherapy; there is however no significant increase in the cure rate to justify this mutilating procedure.

In the lesions which infiltrate and deeply ulcerate, laryngopharyngectomy with postoperative irradiation offers the only chance, though it rarely results in a cure.

MODIFICATION OF THE PRECEDING THERAPEUTIC INDICATIONS IN THE PRESENCE OF CLINICALLY METASTATIC LYMPHADENOPATHY

We have never observed metastatic lymphadenopathy in cancer of the vocal cord or anterior commissure, and have seen only one lymph node metastasis in 100 cases of subglottic cancer, limited to one side of the subglottis.

In vestibular cancer, lymph node metastasis is common and we advise a full course of postoperative irradiation, even in the absence of clinical evidence of this metastasis. We feel that radiotherapy in these cases is of at least as much prophylactic value as radical neck dissection. Clinically metastatic lymph nodes were present either on admission or 18 months after operation in two-thirds of our cases treated solely by surgery. We recently reported 13 of our vestibular cancers without clinical lymph adenopathy on admission, treated solely by surgery, who later developed lymph node metastases and died. In a similar series, of 29 cases treated by laryngectomy, followed by radiotherapy, there were 15 cures.

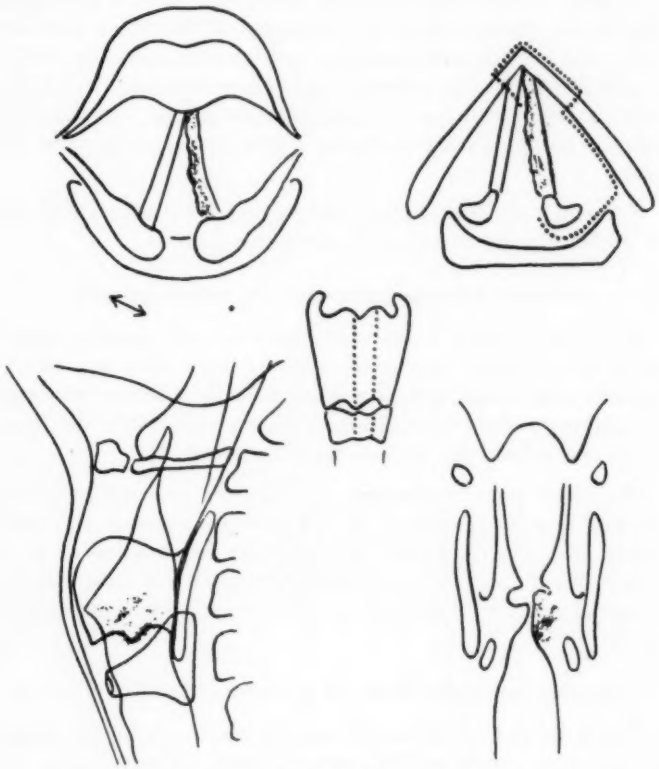
The plan of treatment in the presence of clinically metastatic lymph nodes varies depending on whether the primary lesion is best treated by surgery or by radiotherapy.

PRIMARY LESION BEST TREATED BY SURGERY

In the presence of a single mobile node or a group of mobile nodes less than three centimeters in diameter, we advise total laryngectomy together with en bloc neck dissection, and a full course of postoperative radiotherapy.

If there is a single but fixed node, or one, more than three centimeters in diameter, or if the adenopathy is multiple, radiotherapy is preferred to surgery for treatment of the primary lesion and metastatic lymph nodes. The response to this treatment may vary as follows:

There may be rapid diminution in the size of the lymph nodes as well as in the primary lesion, indicating great radiosensitivity of the tumor; in that case radiotherapy should be continued to an ade-



Unilaterality and subglottic extension valued
on side-face radiography and on tomography

Fig. 4.—Indication for the hemilaryngectomy. Unilateral and glotto sub-glottic cancer fixing the whole or a part of the striked cord.

quate therapeutic dose and the patient be followed carefully thereafter.

The primary lesion may disappear, yet there remains a small residual lymph node; surgical removal of this single node is done without radical neck dissection; radical neck dissection might be dangerous after a complete course of irradiation.

The lymph nodes disappear as a result of radiotherapy, yet the original lesion remains uncontrolled; in that case a total laryngectomy is done, providing a sufficient waiting perioid (two to three months) has elapsed after radiotherapy.

If there is some response to the radiation, but it is not sufficient to rely on this therapy alone, the treatment of choice is a total laryngectomy and radical neck dissection, preceded by 1500r to 1800r per field (enough to permit prompt surgical intervention) and followed by additional radiation up to a full therapeutic dose. In this method the surgery is sandwiched in between pre- and postoperative radiotherapy.

If there is no response to radiotherapy whatsoever, one should desist from surgery, as this will also prove useless.

PRIMARY LESION AMENABLE TO RADIOTHERAPY

When the primary lesion is amenable to radiotherapy alone, the presence of clinically metastatic lymph nodes does not alter the therapeutic indications, as the lymphadenopathy will respond similarly as the primary; should a metastatic node persist while the primary has been controlled, one may excise the node locally.

The above plan of therapy, i.e., surgery or combined surgery and radiotherapy, has resulted in 118 five-year cures in 200 cases of cancer of the larynx. Partial laryngectomy has resulted in 67 five-year cures in 100 cases (55 with partial laryngectomy alone and twelve with partial surgery completed by total laryngectomy or radiotherapy).

THERAPEUTIC INDICATIONS IN HYPOPHARYNGEAL CANCER

Cancer of the hypopharynx usually originates in the pyriform sinus and more rarely on the posterior wall. Those arising in the pyriform sinus are best treated by a combination of surgery and radiotherapy. Cancers of the posterior pharyngeal wall are essentially a radiotherapeutic problem.

Dr. Ennuyer and I have classified cancer of the pyriform sinus according to the site of origin, as follows:

1. Cancer arising at the level of the anteriar angle of the pyriform sinus.
2. Cancer arising from the lateral surface of the aryepiglottic fold.
3. Cancer of the postarytenoid and postcricoid region.
4. Cancer of the lateral wall of the hypopharynx.
5. Cancer of the pharyngo-epiglottic folds.
6. Cancer involving the entire pyriform sinus.

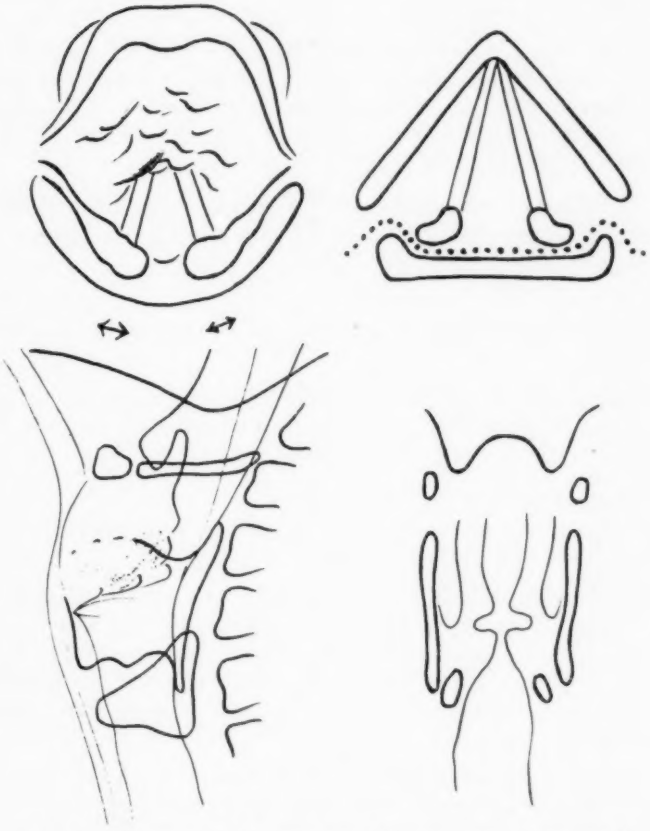


Fig. 5.—Indication for the upper cricoid laryngectomy. Cancer of the posterior face of epiglottis, little extending down to ventricular bands nearly freely movable.

Therapeutic indications in these six varieties differ according to location, anatomic character and presence or absence of clinically metastatic lymph nodes.

If clinically metastatic lymph nodes are absent, cancer of the anterior angle of the pyriform sinus should be treated by total pharyngolaryngectomy, exceptionally by partial pharyngectomy; in either case followed by postoperative radiotherapy. This is done so as to reduce the danger of cervical lymph node metastases, as prophylactic lymph node dissection is not done. Radiotherapy alone is not likely

to cure the primary lesion and metastatic lymph nodes, though this has occurred on rare occasions.

Cancer arising from the lateral surface of the aryepiglottic fold may be treated by radiotherapy alone. A combination of surgery and irradiation increases the chance of cure in these cases. Radiotherapy alone is preferred for exophytic cancers limited in extent, which do not obstruct the hemipharynx on the affected side.

Infiltrating, ulcerating cancers obstructing the affected half of the hemipharynx should be treated by total pharyngolaryngectomy followed by radiotherapy.

Cancers of the retroarytenoid and cricoid area require combined surgery and radiotherapy, as irradiation alone usualy fails to cure these cases.

Cancers of the lateral wall of the hypopharynx sometimes overhang the pyriform sinus, but do not extend down to its base. They should be treated solely by irradiation.

Cancers of the pharyngo-epiglottic fold should also be treated by radiotherapy alone; the results of partial pharyngectomy are not as good as those obtained by adequate radiotherapy.

Cancer of the entire pyriform sinus: This is the type most frequently seen. Treatment is by the "sandwich method," that is, total pharyngolaryngectomy interposed between pre- and postoperative radiotherapy. About 1500r to 1800r per field are given preoperatively, and the rest up to cancericidal dosage are administered after the pharyngolaryngectomy.

The preceding types of pyriform sinus cancers may extend in any of three directions, which may modify therapeutic indications as follows:

Extension towards the endolarynx. This reinforces indication for pharyngolaryngectomy followed by radiotherapy.

Extension toward the oropharynx. This indicates pre-operative radiotherapy and glossopharyngolaryngectomy instead of only pharyngolaryngectomy.

Extension toward the esophageal opening. This reduces the likelihood of a cure, though it does not preclude surgery.

If clinically metastatic lymph nodes are present, the primary lesion is amenable to surgery

If there is a single movable node or a group of nodes less than three centimeters in diameter, total pharyngolaryngectomy, block

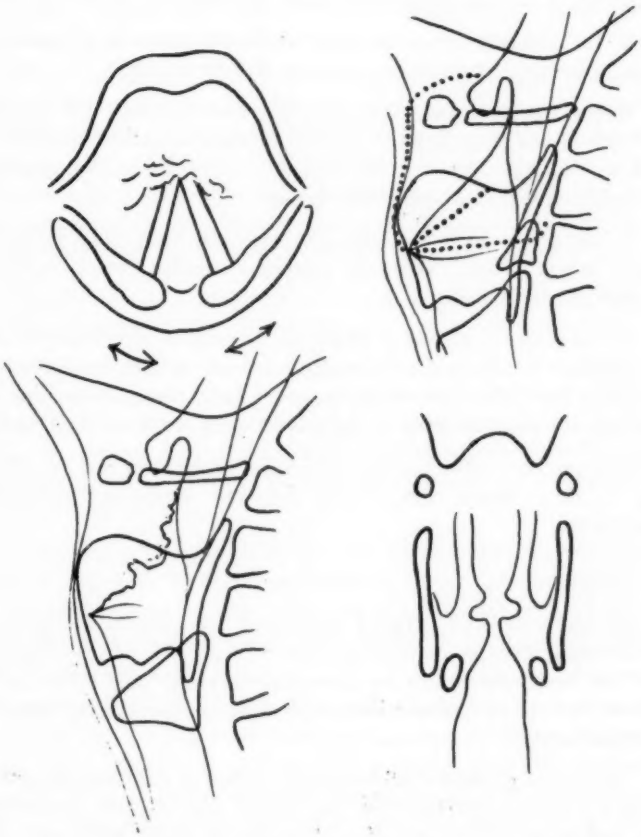


Fig. 6.—Indication for the upper glottic laryngectomy. Cancer of the posterior face of epiglottis not extending down to ventricular bands freely movable.

dissection of cervical nodes, followed by a full course of radiotherapy, should be done.

If the nodes are fixed, are more than three centimeters in diameter and are multiple, radiotherapy is the treatment of choice.

If the primary lesion and nodes start regressing soon after the beginning of the treatment, the primary lesion is amenable to radiotherapy, i.e., radiotherapy is continued to cancericidal dosage.

If the primary lesion disappears as a result of the radiotherapy, yet there is a persisting movable node, it should be locally excised.

If the primary lesion persists while the nodes have been controlled, a total pharyngolaryngectomy should be done.

If the cancer appears moderately radiosensitive, the treatment of choice is pharyngolaryngectomy and radical neck dissection preceded by radiotherapy of 1500r to 1800r and followed by postoperative radiotherapy, to cancericidal dosage.

In cases in which radiotherapy has been absolutely ineffective, surgery is not advised, as in our experience it has not restrained the progress of the disease.

If the primary tumor is likely to respond to radiotherapy alone, the presence of clinically metastatic lymph nodes strengthens the indication for this form of treatment. Local surgical excision may subsequently be considered if there is found a small residual node.

The presence of clinically metastatic nodes does not modify the plan, if the primary tumor is of the type indicating preoperative irradiation.

RESULTS

Of the total 684 surgical operations for cancers of the larynx and laryngo-pharynx performed before July 1954, 145 hypopharynx cases had been operated on by pharyngo-laryngectomy either with or without radical neck dissection and had been followed by systematic roentgentherapy.

Thirty-six of these cases had been treated at the Curie Foundation and more than 5 years before. In 10 of the 36 cases, recovery has been maintained for a period of 5 years or more, while out of the 525 cases, the treatment by roentgentherapy alone yielded but 35 recoveries.

The surgery-roentgentherapy combination seems to result in a higher five-year cure rate than roentgentherapy alone.

The above figures were obtained mainly on cases without clinically metastatic lymph nodes and show that the therapeutic results in these cancers of the pyriform sinus were unquestionably improved when surgery was combined with radiotherapy.

Unfortunately, four-fifths of the patients with pyriform sinus cancer do develop clinically metastatic nodes. All our efforts are at present concentrated on the treatment of this important group, which

we believe should be disposed of as outlined above. As yet we do not have sufficient statistical proof for final conclusions, but our preliminary results are encouraging.

We are interested in partial laryngeal surgery with preservation of the voice. In general we have not combined it with radiotherapy. We limited this surgery to the specific conditions outlined above and were thus able to obtain an 80 per cent five year cure rate in about 100 cases. This cure rate supports our conviction that, when indicated, conservative partial operations are preferable to mutilating total operations for the treatment of limited laryngeal cancer.

The following technical details are of interest in connection with function after partial laryngectomy:

The Hautant type of hemilaryngectomy, in most cases, gives the same functional result as thyrotomy: there is no difficulty with swallowing, no respiratory disturbance and good phonation. Liquids are readily swallowed immediately after the operation; swallowing of solids is difficult for two or three days, and then gradually there is a return to normal.

A tracheotomy tube is left in for several days if the arytenoid is excised. In eight to ten days the tracheotomy tube is removed and the voice returns rapidly to about the same quality as after thyrotomy; there is a little hoarseness but prolonged speaking without fatigue is possible.

Retention of the tracheotomy tube because of contraction of the glottic opening or collapse of the laryngeal cartilage is required exceptionally. In this case phonation necessitates that the patient momentarily close the tube with his finger or use a Broca type tube. Fairly normal respiration is gradually re-established in three or four days after surgery, eight to ten days after the removal of the tracheotomy tube or in the case of a laryngofissure at the time of the healing of the wound.

Cartilage excision must be limited, especially in women, so as to avoid danger of collapse of the larynx; this is more likely if there has been previous exposure of the larynx to radiotherapy.

The above disadvantages have led us to limit our indications for the Hautant type operation and favor what we call the anterior frontolateral laryngectomy. This operation involves resection of a smal triangle of thyroid cartilage at the level of the anterior angle, corresponding to the insertion of the vocal cords. We do not resect the cricoid cartilage, thus avoiding respiratory difficulties and laryn-

geal collapse. Even in extensive lesions involving the superior edge of the cricoid, one can without resecting this cartilage, simply strip the mucous membrane lining its internal surface down to the level of the first tracheal ring.

A tracheotomy tube may be dispensed with in most cases, with anterior frontolateral laryngectomy, if hemostasis is perfect; we use electrocoagulation at multiple points; otherwise a tracheotomy has to be used and pressure tamponnade employed for control of bleeding. The postoperative period of recovery is considerably shortened if a tracheotomy is not used.

Depending on the degree of anterior commissure involvement, frontolateral laryngectomy may be frankly frontal or extend more or less to include the opposite hemilarynx. In the latter case, one must keep in mind the risk of anterior synechiae which may narrow the glottic chink anteriorly and may give rise to permanent respiratory difficulties. The situation may be ameliorated by repeated electrocoagulation of the adhesions. It might be better to reopen the larynx in order to do a wide electrocoagulation under direct vision after a two or three year follow-up, since the vertical extent of the adhesions is usually greater than it appears at first.

Partial horizontal laryngectomy does not increase the risk of recurrence in vestibular cancer, and has the advantage of preserving the vocal cords, but as yet we do not know our long term results.

The main risk is from pulmonary complications which result from aspiration of food; this danger is reduced by providing a gastrostomy opening for a period of four or five months, until the pharyngeal mucous membrane has become readapted and regains normal sensitivity. Sooner or later, the tracheotomy tube may be removed, permitting closure of the tracheotomy opening.

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Translated from the French by M. Bosiaki and F. Mincer.

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XV

FUNCTIONAL DEAFNESS

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The term functional deafness, for the purposes of this article, includes the entire range of non-organic hearing acuity handicaps from classical hysterical and psychogenic deafness to wholly conscious, purposeful, and willful malingering. The term as used here is not intended to include the effect on hearing examinations of mental deficiency, senility, organic central or peripheral diseases. It is the purpose of this paper to discuss the incidence of functional deafness, the important factors which influence its incidence in the veteran population, some of the indicators or signs which will be of assistance in establishing a proper diagnosis, and the problem of determining organic acuity thresholds in cases manifesting some functional loss.

INCIDENCE

The incidence of functional deafness among an unselected population of patients who seek medical care because of ear complaints is probably small. In a questionnaire study of functional deafness in adults as diagnosed in 30 leading public audiology centers, Doerfler[1] reports that 53 per cent of the centers found no cases of functional deafness, while 37 per cent reported an incidence of from one to five per cent. Only 10 per cent of the centers reported an incidence in excess of 5 per cent. In his own clinic Doerfler has found that approximately 3 per cent of the referrals have some degree of non-organic loss. In a recent article, Hanley and Tiffany[2] imply that functional cases are sufficiently rare as to make it necessary to validate a test for non-organic hearing loss on co-operative persons simulating a hearing loss.

Most of the statistics on functional deafness, published as the result of experience in the aural rehabilitation centers during World

War II, indicate that approximately 10 to 15 per cent of the military personnel treated had a hearing loss partly or entirely from non-organic causes. Truex[3] reported that about eight per cent of 4000 hard of hearing military personnel processed at Deshon Army Hospital were found to have a functional loss. Knapp[4] states that experience during World War II demonstrated that some functional hearing loss existed in ten per cent of the hard of hearing military personnel. Martin[5] implies that approximately 15 per cent of all those admitted to the aural rehabilitation centers had some non-organic hearing loss.

In the ten years since the end of World War II there has been a serious increase in the incidence of non-organic deafness among men discharged from the military services with hearing disabilities. The increase has been from 10 per cent to something approaching 50 per cent.

Though the complete data on functional deafness in the veteran population are not yet available a fairly clear picture of the extent of this problem can be obtained from those statistics which have been accumulated. In an unpublished study conducted by Ansberry on a group of 100 veterans issued hearing aids for service connected loss of hearing, 7.3 per cent were later found to have normal hearing. In addition to this group with no hearing problem, 19 per cent had insufficient hearing loss to warrant the use of an aid. There is no doubt that the 7.3 per cent who were found to have normal hearing had a functional loss at the time their level of compensation was established. It is highly probable that a large number of the 19 per cent who were found to have insufficient hearing loss to warrant the use of an aid, had at one time some non-organic hearing loss. The persons included in this study were selected at random from a list of 5000 veterans, all of whom were rated a minimum of 10 per cent disabled and who had previously been issued one or more hearing aids.

In a study conducted by the authors on 500 veterans under 60 years of age referred to a Veterans' Administration Audiology Clinic for problems relating to service incurred hearing disability, the incidence of functional deafness varied from 11 per cent to 45 per cent. In 1951, 11 per cent of the referrals manifested a significant degree (more than 10 db) of non-organic hearing loss; 1952, 23 per cent; 1953, 24 per cent; and 1954, 45 per cent. The increase from 11 per cent to 23 per cent between 1951 and 1952 was attributed to an increased awareness and experience with the problem on the part of the clinical team. The abrupt increase from 23 per cent or 24 per cent to 45 per cent between 1953 and 1954 was attributed to the use of a psychogalvanometric instrument as well as to the fact that

during this period, an unusually large group of veterans were referred for compensation examinations. Previous to this time almost all referrals had been for hearing aid evaluations and compensation, as a rule, had not been a factor. A total of 121 of the 500 veterans included in this study were found to have a significant degree of functional deafness. Twenty-two individuals (18 per cent) manifested a functional loss of 60 db or greater; two of these persons initially failed to respond to 100 db of stimulus but subsequently were found to have normal hearing. The average functional component was approximately 35 db. This study demonstrated that while a significant number of these individuals had a functional overlay to normal hearing acuity, the vast majority had an overlay to an actual organic deficit. The fact that non-organic hearing loss is more highly correlated with a true loss than with normal hearing is an important fact for the examiner to keep in mind.

This study also emphasized the fact that some important factors have been operating since World War II to influence dramatically the incidence of non-organic hearing loss among the veteran group. Since World War II, as has been stated, the incidence of this type of hearing problem among veterans has increased until it involves possibly 50 per cent of those receiving disability awards for loss of hearing acuity. During the last war functional deafness was ascribed primarily to the serviceman's desire to escape from all military service or from some specific type of duty. Although possibly still operative, these motives cannot account for the increased incidence among veterans since late 1945.

There are several factors which probably are responsible for the increase in the incidence of cases of functional deafness between World War II and the present time. Listed in what seems to be their order of importance, three causes are: 1) The monthly compensation policy; 2) the conversational voice hearing test; and 3) inadequate orientation and counseling at the onset of the hearing loss.

The monthly compensation policy, as opposed to the lump sum compensation system, has the obvious disadvantages of focusing the veteran's attention on his handicap and relating the degree of the award to the degree of the disability. When the degree of the award is closely associated with the degree of the hearing loss, the development of a functional overlay is encouraged. It is reasonable to assume that if a lump sum payment had been made upon discharge from the service, the incidence of non-organic deafness in the veteran group would be little greater than that found in the military rehabilitation centers. These statements are not intended to imply that the

Veterans Administration should alter its compensation policies. There are many factors which probably require that the monthly payment system remain in effect. It is our opinion, however, that the present award system has contributed to the development of non-organic hearing loss.

The conversational voice hearing test has contributed to the increase in functional deafness among the veteran population almost as much as has the monthly compensation policy. For many years the degree of compensation paid to a veteran for loss of hearing acuity was based on the results of the conversational voice test. As has been noted by Work,[6] repeated examination by this method and contact with other individuals tested in the same way developed "educated" patients, i.e., persons with functional hearing loss. Lack of standardization of test administration in addition to the fact that the patient was free to respond in any manner he chose made impossible accurate adjudication by this method. Even experienced examiners frequently found no solution to the problem except to make an informed guess as to the extent of the hearing impairment.

The combination of an inexact conversational voice test and the monthly compensation system inevitably resulted in an increase in the incidence of functional deafness among veterans. In addition there is a third factor which has a bearing on this problem and which requires comment. Many cases of functional deafness probably had their origin in inadequate counseling following an acoustic trauma. A number of the veterans studied described the development of their deafness in a manner sufficiently similar so that the following abbreviated but typical history may be drawn. Gunfire on the firing range or blast during combat brought on a temporary deafness. A report to the dispensary produced no treatment and frequently only an immediate return to duty. A residual tinnitus in some probably caused concern, focused attention on, and created resentment for the lack of medical care. Repeated exposure to noise and repeated visits on sick call served only to intensify these feelings. In many cases conscious exaggeration of the auditory symptoms brought attention, treatment, and removal from the source of noise. The development of temporary deafness and tinnitus, as described here, was sufficiently common to indicate that group counseling and orientation sessions should have been provided all military personnel during basic training. In this regard it is not sufficient to counsel individuals after they have reached an aural rehabilitation center. While the counseling and orientation provided at these centers was of great value, most servicemen who sustained acoustic trauma never reached these centers. Of those who were referred to these military units many had already

developed elements of a functional deafness by the time they arrived. In order to be most effective counseling and orientation should be given during basic training. It is only reasonable to assume that counseling sessions designed to provide a few important basic principles pertaining to these problems would reduce some of the anxiety and other feelings brought on by acoustic trauma and would, as a consequence, effect the incidence of functional deafness.

In addition to these three suggested causes of the increase in functional deafness, improvements and developments in testing equipment as well as increased experience with the problem on the part of the examiners have made easier the diagnosis of non-organic hearing loss and consequently increased the percentage of functional cases reported.

DIAGNOSIS

The diagnosis of functional hearing loss seldom should be made on the basis of the results of a single test. This is true whether the functional loss is an overlay to normal hearing or to an actual organic loss. If the degree of the functional overlay is large enough to result in one clue, more than one probably can be uncovered. An unqualified diagnosis of non-organic hearing loss should not be made unless several discrepancies or clues are noted.

Listed below are the most important indications of functional deafness. In addition to the list of clues several special tests are noted which have been found valuable in establishing a diagnosis of functional hearing loss. Many of the tests described in the literature are not considered of value and so are not listed. It is important to recognize that another clinical team with different equipment, a different population of patients, different test preferences and interview techniques would alter the list or attach to these clues varying degrees of significance.

HISTORY AND PHYSICAL EXAMINATION:

1. *Medical Examination.*
   a. Discrepancy between otological findngs and history.
   b. Degree of loss unsupported by history or otological findings.
   c. Total deafness but with normal responses to labyrinthian tests.
   d. Rapidly progressive perceptive hearing loss without evidence of organic disease.
   e. Monaural loss without clear etiology.
   f. Obvious psychiatric disorder.

g. Sudden onset of total bilateral deafness.
h. Normal response to questions during caloric test.
i. Significant responses during pentothal interviews.
j. Unsolicited comments or questions regarding compensation.
k. Discrepancy between stated history and history as found in patient's medical records.
l. Remarks such as: "I can get along fine when I can read your lips." "My ears ring so much I can't hear the tones." "The ringing in my ears confuses me." "I don't do well on these tests." "I don't see how a test with tones will tell you how much trouble I have." "I don't care about the money—it's my hearing that counts." "My hearing fluctuates a lot." "The doctor thought I was faking."

2. *Manner of Listening—Speaking.*

a. Exaggerated attempt to hear.
b. Exaggerated staring—attempt to impress with ability to lip read.
c. Discrepancy between history and articulatory and phonatory patterns.
d. Excessively loud voice.
e. Refusal to attempt lip reading. May force examiner to write.
f. Discrepancy between lip reading ability and hearing loss history.

3. *Hearing Aid Usage.*

a. Wears weak aid with apparent success while professing severe loss.
b. Wears aid turned off or with insignificant degree of volume.
c. Claims regular use of aid but aid shows no sign of wear.
d. Claims severe loss but wears no aid.
e. Claims regular aid usage but has no reasonable idea of the cost of batteries.
f. Claims improbable improvement or lack of improvement from a hearing aid or from therapy.

4. *Miscellaneous.*

a. Obvious nervousness—increases as test progresses.
b. Failure to keep appointment.
c. Alcohol odor or drunkenness.

ACOUSTICAL EXAMINATION:

1. *Fork Tests.*
   a. Fork tests may be incompatible with the history or physical findings.
   b. No lateralization—indefinite responses.
   c. Becker bone conduction test—failure to transfer. Weber Test should lateralize to the occluded ear.
   d. Variation in responses to Rinné and Schwabach on repeated test.
   e. Responds only momentarily to tone.
   f. Denies hearing forks but responds to audiometer between 50 to 60 db.

2. *Pure Tone Audiometer Test.*
   a. Variation in pure tone threshold.
   b. Variation between pure tone test results and the stated history, and between pure tone results and the ability to discriminate either on PB tests or in general conversation.
   c. Saucer audiogram (see discussion).
   d. Incompatibility between bone conduction threshold and discrimination score.
   e. Increased stability and improvement in responses immediately following mention to the patient of "unusual variations."
   f. Slow, deliberate, obviously thoughtful responses.
   g. Bone conduction equally depressed 20-40 db for all frequencies.
   h. Slight movements in finger or hand prior to giving voluntary response to tone.
   i. Bone conduction significantly poorer than air conduction.
   j. Winces in pain to intense sound but refuses to respond voluntarily.
   k. Improvement in unoperated ear following fenestration.

3. *Speech Audiometer Tests.*
   a. Half-word response to spondee test. The half-word response may have no relation to its relative phonetic power. Often given with a rising inflection.
   b. Hesitation and obvious deliberation before giving a response to spondees.

c. Misses spondees at every level.
d. Fluctuating SRT.
e. Discrepancy between best monaural SRT and free field SRT.
f. Responds to questions with ease, but will not repeat spondees at the same level.
g. Responds without error to both spondee and PB tests at between 90 and 100 db with final thresholds of 80 to 90 db.
h. Symmetrical bilateral pure tone loss but significant variation in discrimination scores.

4. *Special Tests.*

a. PGSR Test. Particularly suited for testing adults with functional loss.
b. Doerfler-Stewart Test.
c. Delayed Speech Play Back Test.
d. Stenger and Modified (speech) Stenger.
e. Swinging Voice or Story Test.
f. Lombard. Discrepancy between monaural and binaural Lombard.

Careful study of this list will demonstrate quite clearly that most diagnostic signs of non-organic hearing loss are the result of discrepancies between two pieces of information. Before these discrepancies will seem significant, however, one must be able to recognize the proper relationship between the results of various tests as well as the accepted correlation between certain medical and acoustic data. Certain relationships between a patient's responses to pure tone and speech tests are known; certain allowable variations among repeated threshold responses are well established; and certain types of responses from persons with particular otitic disorders may be expected. There is a striking similarity among the responses of the vast majority of patients with organic hearing loss. The responses of the average functional patient stand out in sharp contrast.

Perhaps the most frequent clue to functional deafness is a significant fluctuation in threshold on repeated pure tone testing. While it is true that functional deafness is usually the ascribable cause of such fluctuations, similar inconsistencies may be elicited in some cases of serous otitis media. Monaural pure tone threshold variations of 10 to 25 db or more may be demonstrated in some of these cases. Slight movements of the patient's head may bring about the sudden and complete decay of a previously clearly audible tone probably

due to the shifting of fluids in the mastoid and middle ear. In contrast to the instability of the pure tone air conduction thresholds, it has been our experience that bone conduction and speech reception thresholds will show only relatively normal threshold variations. A diagnosis of serous otitis cannot be made on the basis of these signs; however, when these audiometric signs do occur, serous otitis should always be ruled out before a diagnosis of functional deafness is made.

The differences between responses of adults with organic and non-organic hearing loss are fairly sharp, except where there is pathology such as serous otitis. There is no clear distinction, however, among the responses of the various types of functional deafness patients. Contrary to rather general belief, most persons manifesting a functional loss, whether the loss is of conscious or unconscious origin, will respond to audiometric examinations in essentially the same manner. The malingering and hysterical patients cannot be differentiated on the basis of the kind of responses they give to various hearing tests. The practiced malingerer, for example, may develop an amazing skill at repeating thresholds with a minimum variation. The true hysterical patient may likewise be capable of reproducing previous responses. Yet the vast majority of all types of persons with functional deafness have difficulty reproducing pure tone or speech thresholds within normal limits. The problem of differential diagnosis is further complicated when there is a possibility that the patient may have seriously reduced intelligence. The moron frequently will respond like the functional case to pure tone and speech tests. Therefore, unless the patient admits he has purposefully fabricated his hearing loss, it is unwise to designate any functional deafness patient as a malingerer. In almost all cases "functional" or "non-organic" are the appropriate terms to describe hearing loss resulting from other than organic disease.

The list of clues presented will be valueless unless regular practice and experience is obtained with patients having a functional hearing loss. The fact that non-organic cases are only rarely seen in public audiology centers should not prevent clinicians from obtaining the necessary experience. Clinical competence at making a valid diagnosis of functional deafness can be developed by serious practice on co-operative persons simulating hearing loss. It is suggested that without previous knowledge each examiner should be regularly scheduled to test a stranger who, with all determination, will attempt to simulate a hearing loss or an overlay to an existing loss. By establishing such a procedure as part of the clinic routine each clinician should be able to develop a background of experience with this problem sufficient to enable him to diagnose cases of functional deafness

when they occur. Practice of this type is particularly essential in centers or clinics which only occasionally have referred industrial deafness cases or only rarely examine patients diagnosed as having a non-organic hearing loss. It is our opinion that the incidence of functional deafness among the hard of hearing public at large would be found to be greater than presently suspected if such practice were made a part of clinic routine. Since most functional deafness is an overlay to an organic loss most of these "practice" sessions should be carried out with persons who actually have some true organic hearing loss.

DETERMINING ORGANIC THRESHOLDS IN PERSONS WITH FUNCTIONAL DEAFNESS

The principal function of most audiology centers is rehabilitation. As a consequence, when a diagnosis of functional deafness has been made attention is directed first to such matters as the need for psychotherapy, counseling, hearing aid usage and various educational procedures. Quite naturally a determination of the degree of organic hearing acuity is of secondary concern. However, when an examination is required for the purpose of obtaining data which will be used to establish a level of compensation or pension in settlement of a claim the degree of organic hearing acuity is of the greatest importance. Whether the claim is against industry or the federal government, when the problem is concerned with how much compensation shall be given an individual for his alleged loss, the commission or adjudication board will have two principal questions: 1) What is the degree of organic hearing acuity? and 2) What was the cause of the hearing loss? If a severe psychiatric condition is involved in the claim the level of compensation and other adjudicative decisions will be established in a perspective affected by the psychiatric disorder; however, the vast majority of claims filed for loss of hearing acuity are not complicated in this way. In most cases where the question of compensation is involved the degree of organic acuity is of primary concern.

Determining the degree of organic hearing acuity in cases manifesting non-organic hearing loss is frequently a difficult task. Because each case is unique it is impossible to describe a specific procedure for determining actual threshold levels. There are three groups of procedures, however, which when combined appropriately usually will allow the examiner to arrive at a reasonably valid measure of the degree of organic hearing acuity. These procedures are: 1) counseling; 2) repeated pure tone and speech threshold examinations; and 3) special tests adapted for use in functional deafness.

The majority of individuals who attempt a functional loss do so with half-determination or half-conviction. Most of these patients will give up the non-organic aspects of their loss if provided the opportunity and offered a little motivation. Approximately two-thirds of all cases found to have a non-organic hearing loss can be induced to give up that loss through counseling. Approached in an understanding manner, most of these persons will voluntarily provide valid and reliable responses and seem relieved to be able to do so. A functional loss of conscious origin usually cannot be removed, however, without providing the patient with a "graceful way out." This is a fundamental in an examination designed to provide a measure of organic hearing acuity. The case may desire to co-operate, but he probably will not feel free to do so unless the examiner is able to help him find his "way out." It is helpful to give him a chance to say he did not understand the directions, or that he was very tired and will be able to perform better next time, etc. The clinician must keep in mind that the task is to obtain valid and reliable thresholds and not to imply to the patient that there has been some conscious fabrication on his part.

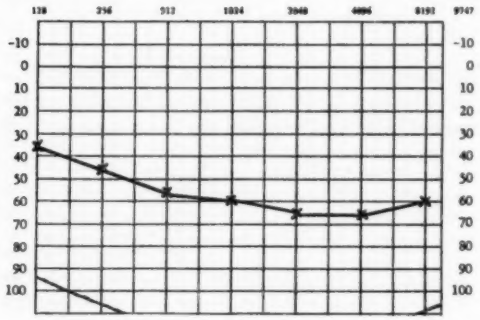
In many patients diagnosed as functionally deaf where suggestion and counseling are not effective in substantially improving the thresholds, measures of organic acuity may be approached through simple repetition of speech and pure tone audiometric examinations. Repetition of the tests serves to demonstrate that the examiner is seriously concerned with the manner in which the examination is progressing. In addition it tends to confuse the patient and disrupts his ability to remember reference levels. Repeated pure tone tests are particularly effective when the audiometer used has a continuously variable frequency. If the hearing loss dial on such an audiometer is set at 5 to 10 db below the admitted threshold at a given frequency and a "sweep" toward that frequency is begun from a higher frequency, the person with a functional overlay usually will get a sensation of increasing intensity. If the gradually changing frequency is heard and if there is a sensation of increasing loudness, the patient may respond to the tone at an intensity level he previously denied hearing. Each time a new threshold is established the hearing loss dial should be set down another 5 to 10 db and the sweep continued. If the true organic hearing is a high frequency perceptive loss, it is more effective to sweep from high frequency to low. A pure tone procedure of this type, if persistently used for many minutes, may result in such confusion of reference level that the patient voluntarily will begin to respond in an accurate manner.

There are several special tests which may be used in an effort to determine thresholds of organic hearing acuity. Among these are the Doerfler-Stewart Test,[7] the Delayed Speech Play Back Test,[2,8] Psychogalvanic Skin Response Test[9] and the Stenger Test.[10] The Doerfler-Stewart test is well known and does not require further discussion. The principle behind the Stenger test and its use as a threshold seeking device is less well known. The Stenger test is based on the fact that if two stimuli, varying only in intensity, are presented simultaneously to both ears the patient will be aware of hearing the stimulus only in the ear hearing it the louder. A masking effect takes place which makes the patient unaware of the presence of a lesser stimulus in the opposite ear. This principle has been used with both pure tone and speech stimuli.[11] The pure tone and modified (speech) Stenger tests have been used successfully in patients with unilateral deafness especially as a diagnostic tool. If the Stenger test is further modified, it can be used as a threshold seeking device for testing persons with a bilateral hearing loss. The test can have important value as a threshold seeking device with bilateral hearing loss if the element of confusion is added to the Stenger's masking principle. Confusion and anxiety may be developed by requiring the patient to respond to a mixture of live voice spondees and appropriate personal questions. At the same time he is repeating spondees and answering questions about himself and his hearing loss he should be requested to indicate by hand signals the ear in which the spondees are heard, i.e., the dominant ear. The patient must be kept under constant pressure to respond and consequently given little opportunity to reflect on his functional reference level. The relative intensity of the speech should be gradually, and occasionally rapidly, varied so that first one ear is dominant and then the other. The intensity of the speech in both ears should be kept close to the most recently admitted thresholds; slightly above the admitted threshold in one ear and slightly below in the other. While the relative intensity between the ears is being varied, there should be a steady decrease in the over-all intensity of the speech in each ear. The channel interrupters should be used frequently. When the patient has become thoroughly confused and aware that a gradual decrease in the over-all intensity of the speech has taken place in both ears, and that he has responded to speech at a level previously denied, he usually will cease responding altogether or gradually give up the functional portions of his hearing loss. In either case the test will have proved of value. At the least the examiner will have obtained information which he can use during the counseling sessions. Ideally, however, he will be able to locate the threshold of organic hearing acuity. There are virtually unlimited variations which may be included in this general procedure.

In addition to the Stenger, Doerfler-Stewart, and these modifications of the Speech Stenger, the Delayed Speech Play Back Test appears to be an excellent tool for use with functional hearing loss problems. The Delayed Speech Play Back Test requires that the patient read out loud some relatively simple material. As he is reading, his speech is recorded and, through earphones, played back to him after a brief delay. When the "delayed speech" is heard by the patient at possibly 20 db above his true organic speech reception threshold, his normal speech patterns are interfered with. In some cases the patient finds it impossible to continue reading. The Delayed Speech Play Back is best adapted for testing persons with relatively flat hearing losses. When there is a functional overlay to a sharply falling high tone organic loss this test may be expected to produce less than satisfactory results.

Though not to be considered as final evidence, psychogalvanic skin response audiometry is an excellent tool which is particularly useful with patients having some functional hearing loss. In a large percentage of functional cases where co-operation cannot be obtained through counseling and repeated testing, the PGSR test will probably provide sufficient information to allow the examiner to make reliable estimates of the organic threshold levels. It is our opinion, however, that the level of compensation or the rating of the percentage of disability should not be based, as a general practice, on the results of the PGSR tests unless these results are supported by other test evidence.

The degree of accuracy as well as the percentage of successful examinations in cases of functional deafness will depend to a large extent upon the ability of the examiner to combine and use these tools in an imaginative manner appropriate to each case. The organic thresholds for pure tone and speech can be obtained in approximately 95 per cent of the cases diagnosed as functional. Five per cent of the cases, though properly diagnosed, will resist effectively all attempts to determine the degree of organic hearing acuity. It is important to state that adherence to routine audiometric methods and techniques, while providing valid diagnostic information in some cases manifesting a functional loss, is virtually valueless for determining thresholds of organic hearing acuity in these cases. Far more than five per cent of the functional cases will resist effectively examinations based on routine and unimaginative procedures. The determination of thresholds of organic hearing acuity in an "educated" case of functional deafness requires versatile equipment and an experienced otologic-audiologic team possessing a thorough understanding of psycho-acoustic principles.

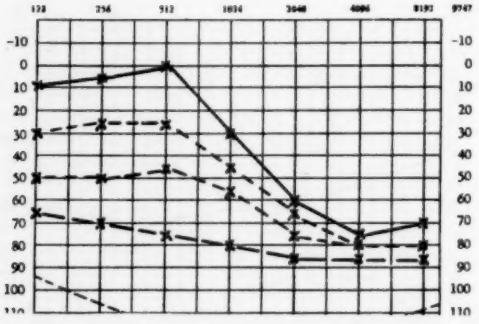


SAUCER AUDIOGRAM

Fig. 1.—Saucer audiogram representing the typical functional hearing loss pattern of a person with normal organic hearing acuity.

SAUCER AUDIOGRAM

Fig. 2.—An audiogram (dotted line) representing the typical functional hearing loss pattern of a person with a 4000 cps organic loss. The curve at the top (solid line) represents organic thresholds for the same individual.



FUNCTIONAL CURVE AND RECRUITMENT

Fig. 3.—Upper curve (solid line) represents organic loss. Bottom curve (broken line) represents functional loss on first test. Intermediate curves show relatively greater improvement for lower frequencies than high on repeated tests and as the functional components of the loss are removed.

THE SAUCER AUDIOGRAM

The saucer audiogram, as one of the manifestations of functional deafness, has been described by Doerfler.[7] A thorough understanding of the reasons for this phenomenon is essential for work with cases of functional hearing loss. Doerfler noted that this audiometric configuration usually was found between 50 and 90 db and was present in 80 per cent of those cases diagnosed as functional. He pointed out that persons with normal hearing manifest a comfortable loudness curve for pure tone which corresponds roughly to the 60 db equal loudness curve. It is assumed that an individual simulating a hearing loss will usually take as his reference level something approximating a comfort level. Therefore a person with normal hearing and simulating a loss of hearing frequently will have a functional loss which corresponds to the 60 db equal loudness contour (Fig. 1).

While it has not been our experience that 80 per cent of all cases manifesting some functional loss will produce a "true" saucer audiogram, this is probably an accurate percentage for persons whose organic thresholds are within the limits of normal or who have an overlay to a conductive loss. Where there is an overlay to a high tone or other perceptive organic loss our experience has been that the functional curve falls off rather than rises in the high frequencies. Rather than a "true" saucer shaped curve the functional curve "overlying" a high frequency loss may resemble a saucergram in the lower

frequencies but will fall off gradually for the frequencies above 1000 cps (Fig. 2).

The psychoacoustic principles which account for a saucergram in normal hearing persons likewise account for the shape of the curve resulting from an overlay to a high frequency organic loss. The tendency to seek a comfort level as the reference point for the functional "threshold" is the same in both cases. The difference in the shape of the two curves (Fig. 1 and Fig. 2) is the result of recruitment. When the effect of recruitment on above threshold levels is taken into consideration, the common non-organic pure tone threshold curve shown in Fig. 2 is explained. It is obvious, then, that when cases manifesting a high frequency organic loss and a functional overlay are required to give up the functional components of the loss as the result of counseling and repeated testing, greater improvement will be noted in the low and mid frequencies than in the high (Fig. 3).

The shape of the functional curve plus the degree of decibel improvement relative to frequency on repeated testing may provide valuable information to the examiner concerning the true audiometric configuration and, in some cases, an indication as to the degree of the organic hearing loss. If we know the true organic thresholds for pure tone for a given individual, our knowledge of equal loudness curves and recruitment affords us some ability to predict the shape of the audiogram if that person simulates a hearing loss. The reverse of this statement of course is not true, i.e., you cannot predict the true organic loss on the basis of the functional audiogram alone. However, if the examiner knows the results of the otologic examination and will observe the shape of the functional curve and the decibel improvement for low frequencies relative to the improvement for the high frequencies he will develop an increasing ability to predict the degree of the organic hearing loss as well as the shape of the true threshold curve.

CONCLUSIONS

1. Functional hearing loss most frequently is an overlay to an actual organic loss rather than to normal hearing.

2. The continuing monthly compensation policy and the use of the classic conversational voice test tend to encourage the development of functional deafness.

3. Counseling and adequate education relating to hearing loss and problems of the hard of hearing given early in the history of the

disability probably would discourage the development of nonorganic hearing loss.

4. The diagnosis of functional deafness and the determination of organic thresholds can be accomplished most effectively through the combined efforts of the otologists and audiologists. The signs or indicators of functional deafness may as commonly come from discrepancies between the medical and acoustical examinations as from either examination separately.

5. Experienced clinical teams with versatile and modern equipment are capable of determining the threshold of organic hearing acuity in 95 percent of the cases of functional deafness.

6. Most persons with a functional deafness, whether from malingering or hysteria, respond in essentially the same manner to pure tone or speech tests.

7. Serous otitis media may bring about fluctuations in pure tone thresholds similar to those caused by functional deafness.

8. A thorough understanding of the causes for the saucer audiogram are essential in work with non-organic hearing loss patients.

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XVI

THE NASAL INDEX

ANTHROPOLOGICAL AND CLINICAL

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The study of the cranial indices has been a subject of much concern to anatomists and anthropologists for many years. This is indicated by the number of indices that have been suggested by students of anatomy and anthropology since the eighteenth century. The nasal index is widely employed in anthropological determinations. Topinard[1] in 1878 made the following statement: "M. Broca has, in fact, discovered that the nasal index is one of the best for the purpose of distinguishing the various races of mankind."

The anthopological investigations on the nasal index furnished the basis for the development of the "cephalometric index" in the living. As these two indices were not applied to the problems of rhinology, they received but little attention from the medical profession. More recently the establishment of a "clinical nasal index" and an "x-ray nasal index" have renewed the interest of rhinologists in these measurements. This thesis presents evidence that the clinical nasal index is important on the assumption that different anatomic types of noses have their own characteristic functional pattern and when reconstructive surgery of the nose is contemplated, the anatomic structure and functional pattern characteristic of the race to which the nose belongs must be taken into consideration.

Topinard described the "anthropological nasal index" as the ratio of the maximum breadth of the anterior orifice (pyriform aperture) of the nose to its maximum length. The length is measured on the skull from the nasal spine to the nasofrontal suture. The width is measured on the skull as the widest distance between the two pyriform crests. Thus the anthropological nasal index is

$$\frac{\text{Nasal width} \times 100}{\text{Nasal height (length)}}$$

Modified from a thesis presented for admission to the American Laryngological, Rhinological and Otological Society, Inc.

He also described the "cephalometric nasal index" which takes into consideration the degree of lateral expansion of the anterior nares as compared with the total length of the nose in the living. In this index the width is measured as the maximum distance between the lateral rims of the alae, and the length is measured on the skin from the nasofrontal suture (nasale) to the subnasal point (subnasale) which he defines as the middle of the inferior border of the nares. If this point cannot be found, he suggests the measurements be taken from the base of the nasal spine. The cephalometric nasal index is further subdivided into a transverse nasal index and an anteroposterior nasal index. The transverse nasal index is

$$\frac{\text{Maximum breadth} \times 100}{\text{Maximum length (height)}}$$

The anteroposterior nasal index of Topinard considers the ratio between the maximum breadth and the total anteroposterior projection of the nose.. Thus the anteroposterior nasal index is

$$\frac{\text{Maximum breadth} \times 100}{\text{Maximum projection of the nose}}$$

The width is measured similarly to that of the transverse and cephalometric indices. The anteroposterior projection is measured from the point of the nose or the tip to the subnasale. The anteroposterior index is of considerable importance from a clinical point of view because it gives us the third dimension of the nose in the living. The maximum breadth or width and the maximum length (height) constitute the other two dimensions of the nose.

Deniker[2] mentions that German anthropologists have taken the measurements for the breadth of the nose, not level with the nostrils, but behind, at the point of their attachment to the maxillary bone, compressing the soft parts. It was his feeling that this resulted in the nasal indices being much too low and not comparable to those of other anthropologists. Schaeffer[3] mentions that the cephalometric nasal index sometimes is determined by considering the length of the nose as extending from the frontonasal suture to the anterior nasal spine. He points out that this obviously does not utilize the greatest length of the nose. In other words, he advocates the utilization of the greatest length of the nose by measuring from the frontonasal suture to the subspine area or the tip of the anterior nasal spine (akanthion).

Later writers on the cephalometric nasal index[4-7] have used Topinard's method for measuring the nasal index in the living. These writers emphasized the importance of the proper location of the

points on the skin over the nasion (nasale) and the subnasion (subnasale). Hrdlicka[8] points out that the nasion is the most important of the landmarks of the face and he further mentions that it is also the most difficult of proper determination. The nasion serves for the measurement of the height of the anatomical face, of the forehead, and of the nose. To find this point on the living, several methods may be used. Hrdlicka[8] emphasizes the need for the student to become familiar with the variations of this point through observation of skulls of both sexes and different ages. This he feels will lead to a fixation in the mind of the observer of the relations of the nasion to the neighboring parts. With such knowledge the location of the point may be determined closely enough for all practical purposes. He also mentions that feeling with one's finger or nail, or the branch of the calipers helps in some instances. He points out that reliance on any level connected with the eyelids, or any fixed distance from the glabella, cannot be recommended due to the variability of these distances and the parts. He differs from Connolly[9] and Ashley-Montagu[10] in this respect.

Hrdlicka further emphasizes the importance of properly locating the subnasal point (subnasale). He feels that this point has not been well defined by writers on anthropometry, excepting Martin.[5] Its indefiniteness is due to the varied development of the fold of skin that connects the nasal septum with the upper lip. He feels that as a rule there is a fairly clear angle here, but it may be filled more or less by the skin-fold or ridge. He states, "The subnasal point can be properly only the summit of the nose-subnasal angle. Where this summit is obscured by a fold, the right measurement can be reached if the line on the septum is prolonged, by pressure of the branch of the caliper that is applied to it, to what would be the summit of the angle if the adventitious skin fold were absent. There is no other means of reaching a proper and uniform mode of securing the measurement."

In 1954 Cottle* suggested a "clinical nasal index" and pointed out its significance in rhinologic problems. The evaluation of rhinologic symptoms, which is especially valuable in the planning of effective reconstructive surgery of the nose, was particularly correlated. Anthropological and ethnological relationships were also presented. In addition, we showed that the clinical nasal index indicates the dimensions of the "nasal aperture" and also suggests the relative proportions of the structures of the external and internal portions of

*Scientific Exhibit, American Medical Association Meeting, San Francisco, 1954.

the nose. The nasal aperture is to be distinguished from the pyriform aperture. It is the entrance into the nasal chambers created when the external nose is removed flush with the face.

The clinical nasal index considers the ratio of the maximum width between the two pyriform crests and the total length or height of the nose measured on the skin in the living. The width is determined by feeling the lateral edges of the crests through the skin, marking them with a skin pencil and measuring the distance between the two marks while they are held in position. For the total length or height of the nose, the measurements are taken from the nasale to the subnasale. The nasale is a point on the skin over the nasofrontal suture in the midline. The subnasale is a point on the skin in the midline immediately below the anterior maxillary spine (anterior nasal spine). The x-ray nasal index should be distinguished from the clinical nasal index. The measurements are taken from the same points, on the x-ray film, which, of course, is subject to distortion. The usual procedure for making the film is to place a small piece of lead on the skin over the nasale and another over the subnasale, holding them in place by a small piece of adhesive tape. The head is positioned so that the Frankfort horizontal line is perpendicular to the film from all sides. The central beam of the x-ray passes through the center of the nose posterior-anteriorly and perpendicular to the film. The distance between the two lead markers on the film represents the length. The distance between the pyriform crests represents the width. The x-ray nasal index helps to indicate further the dimensions and conformity of the nasal chambers.

Since there was considerable confusion and lack of uniformity of cranial measurements among various investigators in anthropology and ethnology, an agreement as to the exact location and definition of various points of measurement for determination of the cranial indices was made at the opening session of the Congress of Prehistoric Anthropology and Ethnology at Monaco on April 7, 1906.[11]

The methods of locating the nasale and the subnasale as previously described by Hrdlicka[8] for the cephalometric nasal index are used to determine these distances in the clinical nasal index. Similar emphasis must be placed upon the location of the points to be measured for determining the width between the pyriform crests in the living. Therefore, it is necessary to become thoroughly acquainted with the ridges of the pyriform crests, marking their location on the skin and measuring the distances with calipers while holding the skin marks in place.

REVIEW OF LITERATURE

In the review of literature on this subject, we are limited essentially to the anthropological nasal index which has generally been considered from the standpoint of racial differences.

Broca, quoted by Topinard,[1] found that the anthropological nasal index varied from 42.3 to 56.9. Topinard[1] continues as follows: "The individual figures in M. Broca's tables vary from 72.22 in a Bosjesman, to 35.71 in a Russian. This interval is divided into three groups, the platyrrhinians, with the nasal skeleton wide, from 53 to 58; the mesorrhinians, with the nasal skeleton moderate, from 48 to 52; and the leptorrhinians, with the nasal skeleton elongated, from 42 to 47. The black races are all in the first group; the Mongols and Americans, with the exception of the Esquimaux, in the second; and the white races in the third."

The division as mentioned above has been made by anthropologists for the purpose of classification of the skulls examined into different racial groups. It was based on the greater and lesser breadth of the nasal opening (pyriform aperture). The skull is called leptorrhine in the long-nosed; platyrrhine refers to the flat-nosed, and the intermediate group was given the name of mesorrhine. The skulls with extremely wide nasal openings were classified as hyperplatyrrhines.

The figures pertaining to these divisions as presented by Topinard and Broca[1] have been further substantiated by later writers on the anthropological nasal index. This is further supported by Deniker.[6] Later anthropological investigators give additional support to these figures. Schaeffer,[3] Cunningham,[12] Ranke,[13] Kroeber,[7] and others give similar figures for the anthropological nasal index.

Under the cephalometric nasal index for these three basic divisions, similar agreement is noted among the various investigators. Figures for the cephalometric nasal index show that the leptorrhinians were below 70; the mesorrhinians from 70 to 85, and the platyrrhinians above 85. Similar figures for the cephalometric nasal index were given by Hrdlicka,[4] Shafer and Thane,[14] Deniker[15] and many others.

In Cunningham's Textbook of Anatomy[12] the form of the pyriform aperture in the macerated skull was considered of value from an ethnic standpoint and to be intimately associated with the shape of the nose in the living.

Schaeffer[3] mentions the value of the cephalometric nasal index on the basis of cosmesis. He states that this index cannot be ignored

in plastic surgery. This is a noteworthy opinion. Fomon[16] refers to the nasal index and gives figures much the same as those previously mentioned. He emphasizes that, for the proper estimation of the nasal deformity, comparison with the face and cranium are essential. He points out that a normal index merely indicates that the relationship of the width to the length is proportionate; but, in order to determine whether this proportion is in harmony with the face, other indices such as those of the face and cranium must be obtained and correlated with the nasal index.

The literature on this subject has shown racial differences from an anthropological and ethnological viewpoint. No reference was found to a clinical nasal index, nor was there any indication that any of the nasal indices had been applied clinically.

Cottle[17] stresses the clinical nasal index as an aid to the evaluation and diagnosis of some rhinologic problems. He also points out that the floor of the pyriform aperture is variable but it is always characteristic of the ethnic origin of each individual. He further emphasizes that the vestibule of the lobule must conform to the patterns dictated by the underlying bone. For example, the floor of the pyriform aperture in colored races is much closer to and usually continuous with the floor of the nose. The vestibule in a Negro nose is similarly continuous with the nasal chamber. In the white races the floor of the pyriform aperture is above the floor of the nose. The floor of the vestibule is below the floor of the pyriform aperture and not continuous with the nasal chambers.

He also emphasizes that the clinical nasal index and the lobular structures must conform to the internal nose of its particular anatomic type and age in order to assure good function. The more common forms of disproportion are: a high nasal index in a white person who has a low, wide, flattened nose, simulating the Negro type; a high nasal index in a nose of substantial projection, simulating a leptorrhine form but in a Negro; noses of adult size but with proportions that obtain in childhood seen especially in white persons.

These disproportions create a variety of clinical symptoms which Cottle[18] has described as the syndromes of nasal disharmony. He has placed emphasis on malformations and lack of conformity of the external structures to the internal nasal structures, both from the standpoint of variations within the white race and from the standpoint of assuming characteristics similar to that of the colored race. For example, the white person having the disproportions of a high nasal index and a low, wide, flattened nose, simulating that of

the Negro type, will often manifest functional disturbances in breathing due to alteration of the direction and velocity of the air currents.

The second form of functional disharmony is exemplified by a relatively high projection and a relatively high clinical nasal index in the nose of a Negro. This type of nose will have the basic external characteristics of a white person and the internal nasal chambers of a Negro. This condition will frequently manifest symptoms of nasal disturbances because the anatomic type is not characteristic of the nasal classification to which the nose belongs.

The third syndrome of disproportion is represented by variations from an infant-type to a child-type lobule, vestibule and cartilaginous vault attached to a relatively normal adult type of bony external nasal pyramid. It is obvious that in many instances such major disproportions in structural relationship will not allow the nose to function as an integrated unit.

The malformations just described may produce a great variety of symptoms and complaints referable to the nose such as referred pain, considerable postnasal discharge, recurrent sore throat, cough, etc. These malformations often result from injuries to the external nasal pyramid (this will be discussed further in the consideration of injuries).

Proetz[19] supports these syndromes of disproportion to the extent that he mentions the important observation that the direction of air currents in the nose is determined initially by the size and shape of the anterior nares. He further points out that the nose is, in a sense, streamlined.

In a recent course the clinical nasal index of 33 cadaver heads was measured. Measurements were also taken from x-ray films made on the cadaver heads and compared with measurements made on the skin. After this, the skin was removed and measurements were made directly on the bony skulls. The three different measurements showed comparable indices. It was found that the leptorrhine clinical nasal index was 61 or less, the anthropological below 47. In the mesorrhines the clinical nasal index was 61 to 65; the anthropological index was 47 to 51. In the platyrrhines the clinical nasal index was 65 to 80, the anthropological 51 to 58. The figures for the cephalometric nasal index are, of course, considerably higher. This is explained by the fact that the width was measured from the lateral rim of each ala rather than from the lateral limits of the pyriform aperture.

Comparative anatomical studies of the nose were made in the white or Caucasian, modern and prehistoric Indian, the Negro race

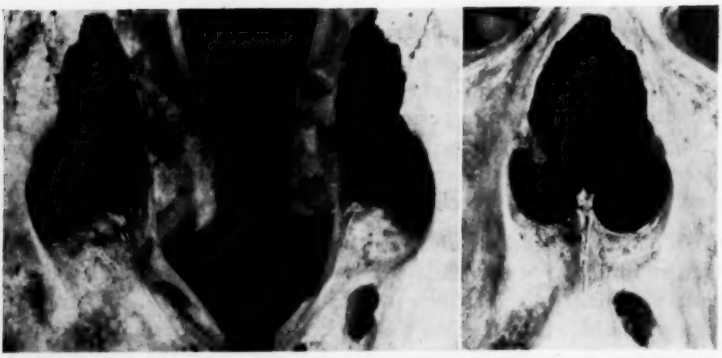


Fig. 1.—Negro skull. Note how pyriform crests seem to fan out on alveolar ridge. A spine is present but there is no definite tendency for the crest to help form the spine as seen in Figure 2.

Fig. 2.—Note contour of pyriform crest actually helping form spine. Note position of insertion of inferior turbinates and relationship of floor of pyriform aperture to floor of nose.

and the ape. The features compared were the size and shape of the pyriform aperture; the nasal aperture; the variations of the contour of the floor of the pyriform crest; the presence or absence of an anterior maxillary spine and the relationship of the floor of the pyriform crest to the floor of the nose. The relative distance of the attachment of the inferior turbinate on the lateral nasal wall to the floor of the nose was also compared.

The following measurements were made on 63 whole skulls and 42 half skulls made available to me at the University of Colorado Medical School, through the courtesy of Dr. Archibald Buchanan, Professor of Anatomy.

In the Caucasians the width between the two pyriform crests on the skulls measured was 20 to 26 mm. The average measurement was 23.3 mm. The distance from the subnasale to the nasion was 49 to 59 mm. The average measurement on the skulls was 54.6 mm. Broca (Topinard[20]) measured 77 men and 47 women from his series of contemporary Parisian skulls. He found the length of the skeleton of the nose to be 51.3 mm in men and 48.3 mm in women. The average width between the two pyriform crests was 24.1 mm in men and 22.7 mm in women.

My measurements showed that in colored races the distance between the two pyriform crests was 25 to 29 mm and the average of the skulls measured was 27.2 mm. The distance from the nasion to the subnasion was 44 to 55 mm and the average of the skulls measured was 49.2 mm (Table I). In the Negro races the pyriform crest varied considerably as it descended and curved medially. In some instances there was a tendency for it to blend into the alveolar ridge, bringing the floor of the pyriform aperture closer to the level of the floor of the nose. In others there was a tendency for it to blend into the anterior maxillary spine. In none of these skulls was there a tendency for it to be as distinct in helping form the anterior maxillary spine as observed in white races (Fig. 1).

In the white skulls the insertion of the inferior turbinate to the lateral nasal wall was approximately 23 mm from the floor of the nose. In the Negro skulls the distance from the insertion of the inferior turbinate to the floor of the nose was approximately 17 mm. The measurements to determine the distance from the insertion of the inferior turbinate to the floor of the nose were taken at approximately 1 centimeter posterior to the most anterior bony attachment of the turbinate. Due to the variations of the attachment of the turbinate to the lateral nasal wall and the absence of a specific point from which to measure, the possibility of error is great; for this

TABLE I.

SKULL MEASUREMENTS

SKULL NO.	WIDTH BETWEEN PYRIFORM CRESTS	NASAL LENGTH OR HEIGHT	NASAL INDEX	SKULL NO.	WIDTH BETWEEN PYRIFORM CRESTS	NASAL LENGTH OR HEIGHT	NASAL INDEX
1	29	44	65.9	32	18	53	34.0
2	24	55	43.6	33	27	53	50.9
3	25	47	53.1	34	22	53	41.5
4	29	51	56.8	35	26	57	45.8
5	26	49	51.0	36	26	54	48.1
6	24	52	46.1	37	27	59	45.7
7	25	49	51.0	38	26	52	40.0
8	24	52	46.1	39	24	52	46.1
9	27	54	50.0	40	23	62	37.0
10	20	54	37.0	41	22	54	40.7
11	23	49	46.9	42	25	52	48.0
12	22	56	49.1	43	23	54	40.7
13	25	50	50.0	44	27	49	55.2
14	28	56	50.0	45	22	56	39.2
15	24	55	43.6	46	25	54	46.2
16	23	54	42.5	47	24	52	46.1
17	23	53	43.0	48	25	59	42.3
18	20	58	34.0	49	24	57	42.1
19	27	55	49.0	50	23	50	46.0
20	23	53	43.4	51	26	53	49.0
21	23	56	41.0	52	24	54	46.2
22	25	53	47.0	53	25	55	47.2
23	25	57	43.8	54	22	56	39.2
24	26	55	47.2	55	23	49	46.9
25	27	50	54.0	56	22	46	47.8
26	24	57	42.1	57	25	51	49.0
27	22	54	40.7	58	28	49	57.1
28	26	58	44.8	59	24	51	47.0
29	27	50	54.0	60	24	49	47.0
30	29	49	59.1	61	26	56	46.4
31	23	53	43.4	62	25	54	48.1
				63	26	55	47.2

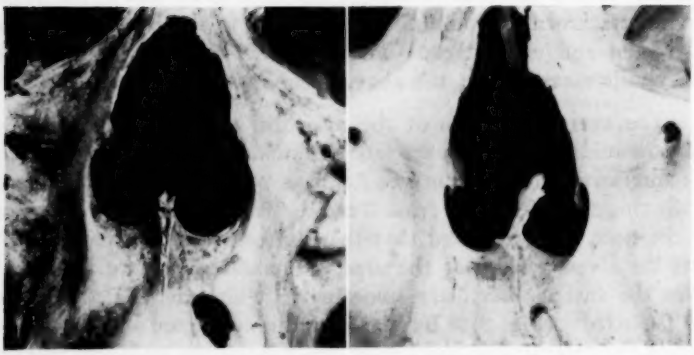
reason the figures given must of necessity be approximate. It has been mentioned that there is a difference of 8 to 10 mm in the height of the attachment of the inferior turbinate to the lateral nasal wall in colored and white races. This difference was not found in the half skulls measured by the above technique.

The average distance of the pyriform crest above the floor of the nose midway between the lateral limit of the pyriform crest and the anterior nasal spine was 4 to 7 mm in white skulls. In the Negro skulls this distance varied from 2 mm below to 4 mm above the floor of the nose. It was noted that the pyriform crest curved medially over the alveolar ridge of the superior maxilla so as actually to help form the anterior maxillary spine in the white races as pointed out by Topinard[21] (Fig. 2). By virtue of this curvature and the formation of the anterior maxillary spine, the floor of the pyriform aperture was found to be considerably above the floor of the nose. In Negroes there was much less differentiation between the floor of the vestibule, the floor of the pyriform aperture and the floor of the nose than in white races.

The size and shape of the pyriform aperture varied in direct ratio to the anthropological nasal index. In those races with a high nasal index, the distance between the pyriform crests was greater, the general contour of the aperture was more oval and the distance from the lower portion of the nasal bones to the floor of the aperture was less than that observed in Caucasian races (Fig. 3). In these latter races it was noted that the distance between the pyriform crests was less, the pyriform aperture assumed a more vertical inclination and the distance between the floor of the pyriform aperture and the nasal bones was greater than it was in Negroes. In the colored race, the pyriform aperture was wider at the base and the over-all length was shorter than in the Caucasian aperture. These findings confirmed those of Cunningham[12] and Gray[22] who considered that the nasal index was intimately associated with the size and shape of the pyriform aperture.

The ape has no nasal spine and the floor of the nose is actually higher than the floor of the pyriform aperture. There is a tendency for the contour of the pyriform crest to extend almost straight down or slightly lateral onto the alveolar ridge of the superior maxilla at the cuspid tooth area.[23]

In an individual with a high clinical nasal index, the external nose was found to have a tendency to be wide and rather flat. There was also a relatively low projection from the face and the air cavity within this structure was smaller and simulated the structural rela-



(a) (b)

Fig. 3.—Note comparison of distance between pyriform crests in (a) Negro; (b) white. Also note how pyriform crest seems to fan out on the alveolar ridge in (a) and on the right side of (b) to help form the nasal spine, but on the left side of (b) the pyriform crest has a tendency to end on the alveolar ridge in the mid-portion of the floor of the aperture. Therefore, the floor of the vestibule on the right side of (b) would be lower than the floor of the aperture but on the left side it could well be higher than the floor of the aperture.

tionship of a colored person. In a person with a lesser clinical nasal index, the external nose had more projection from the face, was narrow and more pointed. Moreover, the air cavity was somewhat larger in this type of nose. In this study it was noted that the size and shape of the nostrils had a definite relationship to the width of the pyriform aperture as well as a definite relationship to the clinical nasal index. The nostrils or the apertures of the vestibule in the white person normally assume a vertical position in their long axis. In the Negro races the nostrils are more ovoid and the long axis is more horizontal.

Asymmetry of the pyriform aperture was noted quite frequently in the skulls that were studied. However, it was observed that sometimes there seemed to have been an attempt on the part of the anterior maxillary spine or the septum to compensate for the asymmetry by deviating toward that portion of the pyriform aperture which was closer to the floor of the nose. In other words, there seemed to have been an attempt on the part of the nasal septum to deviate toward the side in which there was a retardation of growth on the part of the pyriform crest and superior maxilla as seen in Figure 4.

The clinical nasal index in children of the white and colored races is different even in fetal life. Schultz[24] in a study of 320 fetuses, of which 254 were whites and 58 were American Negroes, found that a racial difference exists during the entire development, the Negroes always showing greater averages than the whites. The racial difference exists even in the youngest ages studied. This distinction, according to Schultz, is almost exclusively the result of the difference in the nasal breadth of the two races. He mentions that the changes in the nasal index are dependent upon the relation of the relative increase in size of the nasal height and nasal breadth. He found that the nasal index decreases in both races after birth but always

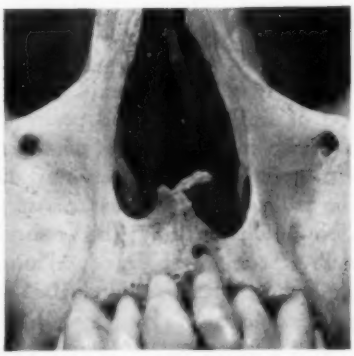


Fig. 4.—Note how septum is deflected to left and pyriform crest is lower on that side.

shows the racial difference. It is my observation that this difference between white and colored children is fairly constant up to approximately five to seven years of age. Thereafter, in normal Caucasians, the anteroposterior projection of the nose increases. The nostrils have a tendency to assume a more vertical position and, proportionately, the clinical nasal index decreases, providing injuries to the cartilaginous pyramid have not altered growth. In the colored child, the nose is not inclined to increase in projection from the face but becomes wider and more flattened while the nostrils continue to retain an ovoid shape and a horizontal position. Subsequently, the nasal index gradually becomes lessened but always remains high.

Injuries to the nose may occur during fetal life, during delivery or any time thereafter.

Interest from a clinical standpoint is basically concerned with the white child primarily because injury to a white child's nose may cause the nose to remain short, wide and flattened, simulating the Negro type. Similar injuries to a colored child's nose do not present such serious problems. However, injury to the nose of a child of either race should be properly evaluated and corrected. In children, as in adults, the most common injury is to the cartilaginous vault. The bony portion of the external nose is less frequently injured but is of equal importance.

Dislocation of the caudal end of the septum is a common injury which may occur during fetal life or during the process of delivery. If uncorrected the dislocation will oftentimes allow the nose to grow in a malformed manner. This, in turn, may have an effect on the normal growth process of the adjacent structures of the cartilaginous and bony pyramid.

During labor the cartilaginous pyramid is frequently compressed for a variable period of time as the head passes through the pelvis. From an obstetrical viewpoint, the longest diameter of the fetal skull is taken to extend from the occiput to the chin. However, the longest diameter may be from the occiput to the tip of the nose and is so often almost as long. Obstetrically, this is not necessarily a problem because the nose is compressible and seldom offers a problem of obstruction. This factor, from a rhinological viewpoint, presents a much more serious problem.

The lobular cartilages may be severely flattened, leaving the spring of the cartilages intact, or they may be so severely compressed that the spring is broken. The first will often correct itself during infant growth but the second type is seldom self corrected during growth. The nasal septum may also be severely injured, even so far as to actually fracture the caudal portion of the septal cartilage. This again, if uncorrected, will alter the normal growth of the nose.

Similar injuries with or without involvement of the bony pyramid may occur after birth from blows to the nose. The injuries may produce various alterations in the growth of the nose and will likewise produce alterations in the normal changes of the clinical nasal index. This helps to emphasize the necessity for study and the correction of the many abnormalities in children that follow injury to the cartilaginous and bony vault (Fig. 5).

Injury to the adolescent or adult cartilaginous or bony pyramid is likewise a common occurrence. This presents a problem equally serious to the injuries in fetal, infant and child life, but it is not so

Fig. 5.—Nose of a person with a history of injury at age 3 which was not corrected. Note deviation of nose to left, dislocation of caudal end of septum to left and flatness of tip.

important from a growth standpoint. A variety of conditions resulting from trauma to the cartilaginous or bony vault may occur. All or any portion of the structures of the cartilaginous and bony pyramid may be involved. As a result of these injuries there may be a loss of projection of the nose from the face. The nose may become widened, shortened and flattened. The injured portions, if not corrected, may heal in any manner, thereby resulting in a malformed nose. The professional prize-fighter and wrestler are excellent examples of this condition.

When loss of projection occurs in white persons as a result of injury, the nasal septum will have been fractured or otherwise distorted, the nose will become flattened and the upper lateral cartilages will assume a more concave attitude toward the nasal septum as compared to the normal convex attitude. The tip of the nose will become flattened and there will be an associated tendency for the alae to flare and extend laterally which results in the long axis of the nostrils assuming a more horizontal position as seen in colored races. As a result of injury the external nose of a white person may, therefore, assume external characteristics of that seen in the Negro and the internal nose will remain Caucasian in all respects. This is important and is an excellent example of one of the syndromes of nasal disharmony as already mentioned. Such a nose, with the external structures simulating characteristics of a Negro with the internal structures of a white person, is in most instances unable to provide the necessary balanced mechanics for good nasal breathing. Similar

conditions in Negroes will also produce many symptoms of breathing and nasal discomfort referable to the nose.

Injury to the nose will often stimulate growth of all or any portion of the structures of the nose. This also presents a problem in evaluation of rhinologic symptoms in direct relationship to the clinical nasal index. It may or may not produce alterations of the nasal structures extensive enough to interfere with the function of a given nose. Alterations to the nose due to injury do not always produce clinical symptoms but the potential is there. Small changes in anatomy may produce marked functional distress in some people. Anatomical malformations of any portions of the nose may be so correlated with the other portions as to allow a nose to function properly. The vast compensatory powers of the nose should not be minimized. It is advisable to use every aid available to diagnose and evaluate properly each individual nose from a functional standpoint. The clinical nasal index is an important aid to help orient us as to what type of nose we are dealing with.

Cottle has suggested that the nose be divided functionally as well as anatomically into an external and an internal nose. The external nose is considered to be that position of the nose outside of the face. Roughly, this is determined by drawing a line from the posterior lateral limit of the nasofrontal suture to the lateral portion of the pyriform crest. That portion anterior to the line is the external nose and the portion posterior to the line represents the internal nose. The external nose is actually a cavity. The turbinates, ethmoid cells, the maxillary and other sinuses are contained in the internal portion of the nose.

A much larger portion of the nose projects from the face in the white person than in the colored person. The question arises as to whether or not the difference in the projection of the external nose engenders a basic difference in the functional patterns of the two anatomic types of noses. A consideration of these suggests that there may be such a different functional pattern. It seems feasible to assume, with Cottle, that all human noses have very similar functions but the nose in a white man is especially efficient as an air-warming apparatus while the nose in a Negro is more effective as an air-cooling apparatus than the white man's. This possible difference in function is further supported by correlating the size and shape of the air cavity which projects from the face with the size and shape of the nostrils. The variations noted in the attachment of the inferior turbinate to the lateral wall of the nose as it relates to the floor of the nose; and the relationship of the floor of the vestibule to the floor of the pyriform aperture, indicate further that the function of these

two distinct anatomical types of noses was meant to be different. Clinical experience has shown that a Negro with a Caucasian-type pyramid with a high clinical index manifests definite disturbances in breathing. Likewise, a Caucasian with a clinical nasal index, vestibule and external nose similar to that of a Negro has disturbances in breathing. Therefore, the problem from a reconstructive surgical standpoint is to alter the size and shape of the vestibule and the size and shape of the cavity so that these portions of the nose will function in accord with the racial characteristics.

The additional diagnostic information gained from this study will continue to help determine whether or not an individual needs surgical correction. If correction is needed, these studies help to determine what procedure or procedures will be best suited. In order to make proper surgical correction of these malformations, it is necessary to have a knowledge of different racial characteristics and the functional patterns common to these races. Actually, the surgical procedures do not change the clinical nasal index materially but do alter the conformation of the nasal aperture. For example, a nose in which the distance between the two pyriform crests is greater than normal the width of the nasal aperture will also be greater. However, when lateral osteotomies and infractures are accomplished and the nasal bones are replaced within the limits of the nasal aperture, the measurements of the nasal aperture are reduced while the measurements of the pyriform aperture remain the same.

Therefore, the clinical significance rests on the assumption that different anatomic types of noses foster more or less definite functional patterns. In order for a given nose to follow its normal functional pattern, the external nasal structures must be properly related to the internal nasal structures characteristic of the racial classification to which it belongs. Since the proportion of the width to the length of the nose shows definite racial variations, it seems reasonable to assume that the direction and velocity of the air currents vary in different anatomic types.

Comparative anatomical studies further support the assumption that each anatomical type of nose has its own characteristic functional pattern.

SUMMARY

The anthropological nasal index and the cephalometric index are the sources from which the clinical nasal index is developed.

The clinical nasal index is intimately associated with the size and shape of the nose. The clinical nasal index is greater in the colored races, Indians and Orientals than in the white races.

Two basic anatomic types of noses—the Caucasian and the Negro—have been compared. It is suggested that each has a characteristic functional pattern.

Syndromes of nasal functional disharmonies are presented and defined. Injury to a white child's nose may alter the normal growth enough to produce in adulthood a nose with a high nasal index.

It is suggested that a basic understanding of these two anatomic types—the white and the Negro—and their respective functional patterns is necessary to make a proper evaluation of a nose. Such an understanding is also essential in determining the proper procedures necessary for reconstructing a disproportioned nose so that it will function in keeping with the anatomic type and functional pattern characteristic of the race to which it belongs.

The clinical nasal index is an aid in evaluating rhinological problems.

408 HYNDS BLDG.

The author is indebted to Dr. Cottle for permission to use the data in this thesis.

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XVII

MEASUREMENT OF AUDITORY THRESHOLDS BEFORE AND AFTER STRENUOUS PHYSICAL EXERCISE

A PRELIMINARY REPORT

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The senior author of this paper, as a physician, has long been interested in problems relating to sedentary living, and in the importance of physical activity in the development and maintenance of personal health. The junior author has been primarily concerned with measurements of auditory thresholds. In combining the interests of both authors for a series of co-operative investigations,[1] some speculations regarding the effect of physical exercise on the auditory threshold had been made. Basically, it might be reasoned that strenuous exercise (with its accompanying increase in circulation rate and increased oxygen supply to the end organs) might result in greater hearing sensitivity. On the other hand, consideration must be given to physiological noises present;[2] the possibility of influence of this phenomenon was also brought to our attention by Kraus,[3] Henderson,[4] and Stevens.[5] Having in mind these considerations, it was rationalized that the increased physiological noises which to varying degrees accompany strenuous physical exertion, such as aberrant sounds from the deep breathing sometimes heard under the earphones, or the internal bodily sounds recognized as "pounding in the ears" which are presumably of cardio vascular origin, might operate to mask out theoretically increased hearing sensitivity resulting from the greater amounts of blood and oxygen delivered per unit of time to the organ of hearing. We are not familiar with reports in the scientific literature dealing directly with this relationship between hearing acuity and strenuous physical exercise.

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The clinical experimental study was conducted using the environmental facilities in the Physical Environment Unit, Graduate College, University of Illinois, Urbana.

In an effort to secure more information on this relationship, we have undertaken to study the changes in auditory threshold as measured in healthy young male subjects, aged 20 to 28 years, following specified periods and quantities of bodily work output. The specific hypothesis under scrutiny was that the hearing threshold probably would be more acute following increased physiological work output.

ENVIRONMENTAL CONTROLS

Temperature and Humidity. All clinical and audiometric measurements conducted in this study were performed in the Physical Environment Unit laboratory with the temperature being kept at 76° F (± 2 degrees), and the humidity at 44 per cent (± 3 per cent). Thus, with constant temperature, there presumably was no significant change in the speed of sound throughout the experiment.

Barometric Pressure. All testing was done at the Physical Environment Unit which is 722 feet above sea level, and where the daily barometric pressures vary between 745 to 755 mm/Hg, averaging 750 mm/Hg.

Noise. During the determination of all hearing thresholds room noise was kept at the very lowest level possible. The author obtaining the audiometric thresholds (E.T.C.) worked with minimal conversation, and each subject indicated his response by finger signal. Other observers present stopped work and remained silent. Any items of room equipment giving noise (e.g., fans, air-conditioning apparatus, etc.) were shut off momentarily during actual threshold finding procedure. This did not produce significant changes in basic room conditions of temperature and humidity.

EQUIPMENT

Equipment for Measurement of Hearing Acuity. The instrument used in this study was a Model 53-C audiometer manufactured by the Audio Development Company of Minneapolis, Minnesota. This audiometer had just been calibrated at the factory, and was reserved exclusively for the measurements in this study. The machine was checked at the onset of the investigation by a psychophysical calibration against ten adults with known normal hearing. The accuracy of the audiometer was rechecked each day before use in the specific measurement situations.

Equipment for Measuring Blood Pressure and Heart Rate. All heart determinations were made using a Bell style stethescope held over the area of the chest overlying the heart (precordium), and the heart beats were carefully counted for 30 seconds and then multi-

plied by two to obtain the rate per minute. Blood pressure readings were made with a standard sphygmomanometer, Baumanometer instrument, using a Bell style stethescope.

Equipment Employed for Producing Strenuous Physical Exertion. For this purpose, all subjects were required to operate a Kelso-Hellebrandt bicycle ergometer[6] over a fifteen minute period, and to so work at sufficient intensity to increase their cardiac output five or six times the normal resting level. According to Evans,[7] physical exertion which increases the cardiac output three to eight times the resting level may be called "hard work."

SUBJECTS

In this experimental study all subjects employed were adult males, most of them majors in physical education. The age range of the subjects was 20 to 28 years, the period in which humans apparently possess the greatest auditory sensitivity.[8] The subjects showed no greater deviation from established normal hearing thresholds than five decibels at a single frequency between 125 and 12,500 cycles. All subjects passed a routine medical examination similar in scope to that of the Class 3 medical examination required by the Civil Aeronautical Authority for student fliers. In addition, all subjects were required to pass normal urine, blood count, and electrocardiographic supplemental laboratory examinations. No subject was accepted who had any significant history of previous systemic infections, head injuries, etc., which might have left as a residue some impairment of the organ of hearing.

During the experimental periods of exercise all subjects were under continuous medical supervision. During these same periods, the environmental factors which conceivably could mask auditory response were constantly checked by the audiometrician.

PROCEDURE

The auditory threshold for each subject was measured with the subject under quiet resting conditions. Thresholds were obtained by air conduction for the frequencies: 250, 500, 1000, 2000, 4000, and 8000 cycles per second (c.p.s.). Bone conduction thresholds for 250, 500, 1000, 2000, and 4000 cycles per second (c.p.s.) were measured to the nearest five decibel unit—the smallest measurable unit on the audiometer employed in the study. A specialized "ear-choice technique"[9] was employed for obtaining the thresholds. The use of this technique enabled all air conduction and bone conduction thresholds for each subject to be completed in a period of from three to seven minutes.

As soon as the measurement of the auditory acuity in the quiet resting state had been completed, the subject was given continuous exercise on the Kelso-Hellebrandt bicycle ergometer over a fifteen minute period, and of sufficient intensity and duration to increase the estimated cardiac output of the individual five or six times the estimated resting level. It was felt that a work load of this magnitude should effectively increase the blood circulation and the rate of oxygen delivery to the end organ of hearing.

The employment of a technique for estimating cardiac output was adopted for three reasons. First, this was considered a pilot study, and it was felt that estimation of the work of the heart was satisfactory for our immediate purposes. According to the writings of medical physiologists, such as Evans,[7] one can conclude that the type of physical exertion used in this study can be classified as "hard work" inasmuch as the exercise cardiac output in the subjects examined presumably is raised five or six times over their resting cardiac output. Secondly, neither time nor facilities permitted the use of some one of the standard physiological gasometric techniques for the actual measurement of cardiac output. Thirdly, it was desired to utilize a new mathematical formula method for estimating cardiac output, one which requires only a few readily obtained clinical data: sex, age, heart rate, and blood pressure. The rationale and technique of this formula, which was devised by Gubner out of studies made by him using a great quantity of medical insurance records and data, will be reported in a later publication by Boys and Blyth.[10] In this unpublished study, a series of clinical research publications were reviewed which, besides giving gasometric cardiac output measurements, also contained enough data to permit the estimation of the cardiac outputs using the Gubner formula. Comparing actual with estimated figures, the results suggested that cardiac output can be estimated with surprising accuracy in both the resting and exercise states.

Specifically, all subjects rode a Kelso-Hellebrandt bicycle ergometer[1,6] for 15 minutes of strenuous exercise, and performed the following work load stages (Table I). During the first five minutes, the work was at the rate of 3217 foot pounds per minute. In the next five minute period, the work load was increased to the rate of 5448 foot pounds per minute. During the third and final five minute period, the work load was 8263 foot pounds per minute. This 15 minute period of physical exertion was strenuous enough that not all of the healthy young male subjects could complete it because of their legs tiring out. In these instances, the exercise was terminated when required. The data with which the various work loads were determined is given in Table I. The Kelso-Hellebrandt bicycle

ergometer used in this study has been calibrated by Oehmke, and the work load figures cited in the text above are based on his calibration charts and calculations.

TABLE I.

MINUTES OF WORK	FIELD CURRENT (AMPERES)	LOAD TERMINAL (VOLTS)	RATE OF PEDALLING (R.P.M.)	WORK (WATTS)	WORK RATE (FOOT POUNDS PER MINUTE)
1- 5	3.0	3.0	30	72.7	3217.70
6-10	4.0	4.0	30	124.0	5488.24
11-15	5.0	5.0	30	186.0	8263.34

Starting within five seconds of the cessation of the described bicycle ergometer exercise, the subject stepped off the bicycle and moved to a chair beside a nearby table on which the audiometer was located. Immediately, the hearing acuity of the subject was again obtained for air conduction and bone conduction by the same procedure and under identical environmental conditions as in the pre-exercise audiometric measurement. The differences between the auditory thresholds before and after exercise are the figures reported in Table II.

TABLE II.

CHANGES IN AUDIOMETRIC THRESHOLD UNDER (A) QUIET RESTING CIRCULATORY CONDITIONS AND (B) FOLLOWING SPECIFIED BICYCLE ERGOMETER EXERCISE TO INCREASE CIRCULATION RATE

A.

Changes in Audiometric Thresholds (db) Employing Both Bone and Air Conduction

CHANGES IN THRESHOLD (DB)	BONE CONDUCTION	AIR CONDUCTION	TOTAL (AC + BC)
+20	1	0	1
+15	0	1	1
+10	6	3	9
+ 5	13	19	32
0	36	39	75
— 5	9	20	29
—10	3	1	4
—15	2	1	3
Total Ears	70	84	154

B.

Changes in Bone Conduction Thresholds (db) for Each of 5 Test Frequencies Studied

CHANGES IN THRESHOLD (DB)	FREQUENCIES (C.P.S.) 250	500	1000	2000	4000	Total
+20	0	0	0	0	1	1
+15	0	0	0	0	0	0
+10	1	0	3	1	1	6
+ 5	3	2	1	6	1	13
0	8	10	5	4	9	36
— 5	1	2	3	2	1	9
—10	1	0	2	0	0	3
—15	0	0	0	1	1	2
Total Ears	14	14	14	14	14	70

C.

Changes in Air Conduction Thresholds (db) for Each of 6 Test Frequencies Studied

CHANGES IN THRESHOLD (DB)	FREQUENCIES (C.P.S.) 250	500	1000	2000	4000	8000	Total
+15	0	0	0	0	0	1	1
+10	1	0	0	0	2	0	3
+ 5	3	2	3	4	5	2	19
0	8	7	8	8	2	6	39
— 5	1	5	3	2	5	4	20
—10	0	0	0	0	0	1	1
—15	1	0	0	0	0	0	1
Total Ears	14	14	14	14	14	14	84

RESULTS

Casual inspection reveals that in each of the three parts of Table II there was essentially no change in threshold acuity of hearing before and after exercise. Examination of the table reveals that increases and decreases were essentialy equally divided among the thresholds measured. That is, the increased rate of arterial blood circulation due to the exercise at normal atmospheric conditions was not reflected at the time of audiometric measurement in a discernible change in hearing acuity. The sign test[11] was used in an effort to quantify the general observation that no significant change had occurred. This

formal test did not indicate any statistically significant change in the thresholds.

COMMENT

In this experiment, the hypothesis to be tested was that hearing acuity presumably would be improved with increase in circulation rate. With our subjects breathing normal air at ground level atmospheric conditions, increasing the circulation rate approximately five or six fold did not alter the metabolism of the auditory apparatus sufficiently to give any measurable change in hearing acuity. It should be noted that if we acknowledge the presence of physiological noise in the earphones following the described exercise, the masking effect of this physiological noise conceivably might actually decrease the hearing sensitivity. The fact that the obtained thresholds did not show any decreased sensitivity might be interpreted to indicate that in reality the actual threshold (although to some extent masked by physiological noise) in this case series was more sensitive following the exercise.

CONCLUSION

The evidence of the present investigation certainly is not definitive enough to answer the basic problem. However, it does suggest additional study involving experimental designs suited to measure the masking effect of the physiological noise on thresholds of hearing acuity.

321 Illini Hall

The authors wish to thank Mr. George Oehmke for providing them with the carefully constructed work load calibration charts for the Kelso-Hellebrandt bicycle ergometer employed.

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XVIII

CHARACTERISTICS PECULIAR TO THE CARTILAGINOUS SEPTUM OF THE NOSE

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The cartilaginous nasal septum has always been and still remains one of the most difficult tissues to consider in operating on the interior of the nose. There are some histological characteristics of this cartilage which make it an almost unique tissue of the body. Some of these peculiarities have been generally overlooked in plastic surgery of the septum.

In the developing embryo, all tissues arise by the differentiation of largely undifferentiated cellular material. The embryonic tissue from which the connective tissue elements arise, known as mesenchyme, never completely differentiates everywhere into more specialized cells, but in some locations in the body its growth potential still persists.

In the beginning the mesenchymal layer, from which cartilage forms, is a mass of loosely connected cells with fiber processes. Cartilage cells derive from one surface of this layer, by their secretion of a homogenous substance, which as it increases separates the original cells farther and farther apart, until the original lose their form, and only their nuclei remain embedded in the secreted substance at varying distances apart; usually there are relatively few cells present. When the cells have reached a certain stage in their secretory activity and production has stopped, the nuclei themselves may divide, so that two or sometimes more cells lie in a single space. This tissue is now cartilage, and it is still surrounded by the remainder of the layer of cellular elements from which it arose.

The surrounding cellular layer is not actually a capsule but a continuous part of the entire cartilage analagous, but in no way identical, with the layers of the skin which are all intimate parts of the skin that have differentiated by layers into cells of histologically different types.

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The analogy to the skin can be seen further in its lower layers, which still retain their growth potential, and so are able to form new differentiated cell layers, which it does constantly, as the cells of the outer layers move upward and are cast off.

Different from the skin, the cartilage-forming cells differentiate away from the surface, until their growth potential is exhausted, and then remain static.

The most important meaning of this consideration is the fact that the outcellular fibrous layers of the septal cartilage, which in general resemble connective tissue, are not separated from the cartilage, but are part of it. Thus, the term perichondrium is a misnomer and should be considered from the same point of view as the epithelium of the skin; and, therefore, be called epichondrium.

If this should be regarded by anyone as only of academic interest, there remains the fact that operating on the septal cartilage is the crucial test of successful surgery, for the rhinologist. There is no more possibility of "elevating" the outer layers of the septal cartilage than there is of a surgical separation of the different layers of the skin. Further emphasis should be given to the reminder that the comparison to the skin is only an analogous one, since the skin and cartilage are of entirely different derviation, arising from altogether different embryonic elements.

In view of these characteristics, the cartilaginous septum is different from cartilage elsewhere, since in other parts of the body it is not covered by a ciliated mucous membrane; furthermore, with the exception of the joint cartilages, it is surrounded by connective tissue sheaths.

Like all hyaline cartilage, which the septal cartilage is, it has no capillary bed to supply it with blood. Cartilage of this type particularly has a concentrated colloidal structure, consisting of protein in combination with other substances, as chondromucoid, chondroitin sulphuric acid, and albumoid.[1] Lacking an arteriovenous supply of its own, it is in all probability provided for by the fluid of the circulating blood, which permeates intercellular substances everywhere. With its colloidal nature, fluids are easily diffusible throughout its entire structure. Much fluid could be adequately supplied by the capillaries that are abundant in the vascular network of the mucosal covering of the septum.

The fact is well recognized that the maintenance of a viable septal cartilage in rhinoplasty depends first of all on its continuing blood supply. With this fluid in mind, there is one anatomical and

physiological point which may be of considerable importance in this relation.

Little attention appears to have been paid to a submucous vascular provision over the lower third of the septal cartilage, which has been described in some detail.[8] This is a more or less focal mass of cavernous tissue (Schwellenkörper) which lies on the septum just opposite the space between the lower and middle turbinates, into which it fits when it is distended with blood, and which determines its size and shape. By its position, it becomes apposed to the margins of the corresponding turbinates, which are also furnished with more or less focal cavernous structures. When all of this highly vascular tissue is expanded by increased flow of blood, the passageway can be entirely occluded. Complete nasal occlusion is said to be possible only when this reaction is present in a high degree, both of the tissues on the septum and on the lower turbinates. Tumescence of a single focus, or of those over the turbinates only, cannot completely close the airway.

What relation, if any, this vascular tissue has to the septal cartilage in surgery has apparently not yet been determined. It is present both in animals and in infants.

This paper is a preliminary presentation of these peculiarities of the cartilaginous septum, which have not had exhaustive study, but might well add to greater understanding and success in septal surgery

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XIX

MODIFIED RADICAL MASTOIDECTOMY WITH RECONSTRUCTION OF THE EAR CANAL

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Two theories have been used to explain the origin of aural cholesteatomata. The most commonly taught has been that cholesteatomata are secondary to infection. The other theory, that of congenital origin, has been favored by fewer writers. For the following reasons I favor the congenital origin of cholesteatomata:

1. Almost all perforations are in Shrapnell's membrane.

2. Many patients with a cholesteatoma on one side have varying degrees of invagination of the opposite Shrapnell's membrane.

3. Bilateral cholesteatomata with perforations in Shrapnell's membranes are occasionally seen.

4. Perforations in the drum, secondary to infection, usually occur in the pars tensa rather than Shrapnell's membrane.

5. In the development of the ear, the annulus tympanicus is an incomplete ring of bone. The incomplete part is located superiorly. It is not difficult to understand how a failure of development could leave a bony opening in this area lined by squamous epithelium.

Exteriorization of the mastoid cavity is not necessary in most cases of cholesteatoma in present day surgery. This new concept is aided by modern antibiotics and the end-aural approach to the attic of the middle ear. The operation described below uses the same approach as the procedure described by G. E. Shambaugh.[11] The cholesteatoma sac is dissected out, amputated at its attachment to the ear drum and canal, and the wound closed. This leaves the patient with an ear canal and no mastoidectomy cavity.

REVIEW OF THE LITERATURE

Exteriorization of the mastoid has been the end result of the classical types of modified radical and radical mastoidectomies for

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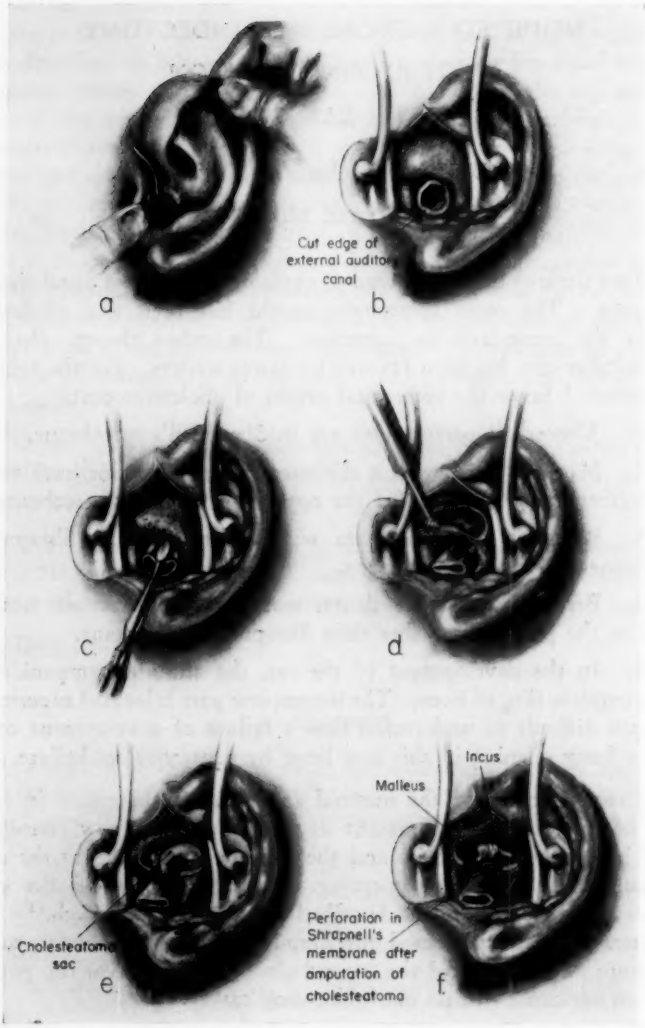
Cut edge of external auditory canal
a
b
c
d
Cholesteatoma sac
e
Malleus
Incus
Perforation in Shrapnell's membrane after amputation of cholesteatoma
f

Fig. 1.—a) The Shambaugh endaural incision.

b) The Shambaugh endaural incision with retractor in place and mastoid cortex exposed. (Consent was obtained from G. E. Shambaugh, Jr. and Acta Otolaryngologica to reprint this and the two following drawings.)

c) The mastoid cortex and the attic area exposed. The elevator is separating the skin of the ear canal from the posterior and superior wall of the ear canal.

d) The burr removing the bone from the lateral wall of the attic. It should be noted that the posterior-superior bony canal wall has been left intact at this stage of the procedure.

e) The lateral wall of the epitympanic space completely removed leaving the bridge of bone to which the eardrum is attached. The malleus and incus can be seen in the depth of the incision. The cholesteatoma is visualized as a sac lying posterior to the ossicles.

f) The same as the previous illustration with the exception that the cholesteatoma has been removed leaving an opening in the ear canal wall just lateral to the incus. After completing the procedure as far as shown in e), the bridge is removed flush with the anterior and posterior canal walls, the cavity is meticulously cleansed and the incision is completely closed. The ear canal is then filled with rubber sponges saturated in appropriate antibiotic solution.

many years. Performing the surgery, however, has largely shifted from the postauricular approach to the end-aural approach as more and more surgeons are trained in present-day methods. The literature was reviewed for the past thirteen years with reference to the surgical procedures for chronic mastoid infections. Simpson[14] described the time-honored postauricular technique in its classical form. With the advent of the sulfonamides and antibiotics, others[2,4] enthusiastically proposed primary closure of the postauricular wound. Many articles compare the pros and cons of the postauricular versus the end-aural technique. Some authors felt that a radical mastoidectomy should almost always be used for chronic infections and that only in rare cases should the modified radical operation be used. These authors did not have the advantage of our present-day antibiotics before and during surgery. Sheridan[12,13] recommended routine removal of the incus and the head of the malleus to make removing of the products of infection easier. This procedure, of course, unnecessarily sacrificed some patients' hearing by routinely breaking the ossicular chain. Whitaker, Juers, and Shambaugh[17] made a great contribution to the end-aural technique with the modified end-aural incision described in 1947. This incision gave adequate exposure without loss of skin. Without this incision, the following technique would have been impossible. Meurman and Ojala[10] described a technique for obliterating the large postoperative mastoid cavities by swinging a muscle flap from the sternomastoid muscle into the cavity. This procedure serves admirably to help reduce the size of some of the large crusting cavities following the classical procedure.

The technique here described was developed independently without knowledge of any similar procedure being previously described. Sheridan, however, in 1943 described briefly a similar technique postauricularly. He described further results with preservation of the meatal flap in 1950. These operations were done postauricularly and, according to his article, the incus and the head of the malleus were removed in all cases. Nonetheless, the large cavities of former years were avoided in Sheridan's hands without serious complications.

A revision of the accepted procedure is proposed because with that procedure the patient remains an ear cripple. He has a surgical cul de sac in his mastoid which collects debris and infection. He must visit the doctor periodically and have the cavity cleansed. He must exercise extreme care to keep water out of the cavity. He cannot swim. After both mastoid and fenestration surgery, the continued necessity of cleansing the mastoid cavity of crusts, debris, and products of infection, which often form in its posterior part, is annoying to both the patient and the doctor. This infection often occurs

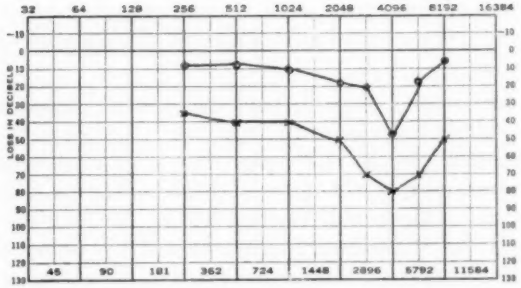

Fig. 2.—G. S. April 7, 1954. Audiogram before mastoidectomy. A cholesteatoma was present in the left ear.

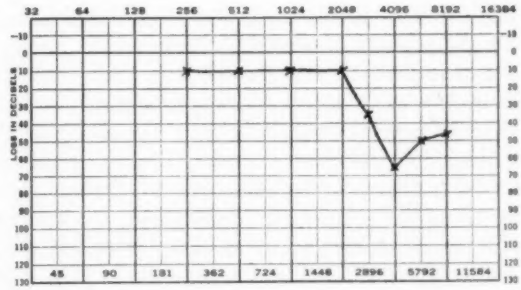

Fig. 3.—G. S. May 11, 1954. Audiogram showing improvement in hearing in the left ear approximately five weeks following operation.

from getting water in the mastoid cavity with subsequent maceration of the skin. This is followed by bacterial invasion resulting in a wet, often foul smelling, cavity. It is difficult for many patients to keep their ears dry when washing their hair despite the use of lamb's wool plugs and other special ear molds. Many patients with dry cavities require crust removal every three months to keep their cavities moderately clean. Even with regular cleansing, crusting in the cavity causes an uncomfortable sensation during such motions as eating and talking.

This operation is proposed only in cases of cholesteatomata in which the middle ear is clean and the disease is limited to the attic area and the mastoid cavity. Demonstration of a clean middle ear is done by examination of the drum with magnification and the pneumatic otoscope. Absence of communication between the attic perforation and the middle ear is demonstrated by asking the patient to inflate the middle ear using the Valsalva maneuver or by using a Politzer bag or an eustachian catheter. Observation of the eardrums, especially the posterior-superior quadrant, during these maneuvers will demonstrate a bulge in the drum and no air will escape through the perforation in the attic. In these cases, we are confronted with a sac lined by squamous epithelium and filled with products of degenerating epithelium and infection. The sac almost always opens into the ear canal, usually through the attic or a marginal perforation located posteriorly or superiorly. The sac may or may not be surrounded by granulation tissue and pus. Often these perforations actually come through the ear canal and leave a demonstrable rim of bone between the perforation and the annulus. There may be erosion of the ossicles or interruption of the ossicular chain without an opening into the middle ear cavity. If the perforation lies lateral to the incus, the chain of ossicles is usually intact. If, however, the opening is medial to the incus, the chain is usually broken at the long process of the incus. Occasionally, the VII nerve lies exposed on the medial wall of the attic of the middle ear. Sometimes, the head of the malleus or the incus are destroyed by disease. None of these circumstances, however, contra-indicates the procedure if the disease can be eradicated without exteriorizing the middle ear. A few labyrinthine fistulas have been seen at surgery. In these, healing has also taken place with no complications. It is, however, absolutely necessary that all diseased tissue be removed meticulously under magnification and with copious saline irrigation. The extent of destruction of structures in the attic and middle ear is the prime factor in the decision as to whether to exteriorize the mastoid or reconstruct the ear canal. More recently, patients with a cholesteatoma, complicated by minimal middle ear infection with a small perforation, have

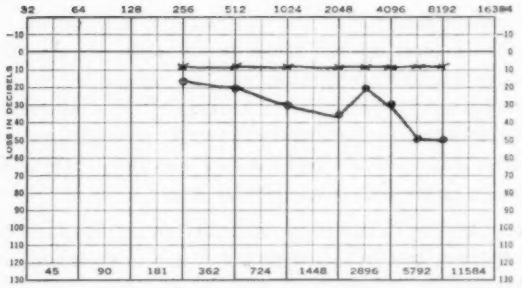

Fig. 4.—L. H. August 1, 1954. Audiogram showing hearing loss in the right ear prior to mastoidectomy. The patient had a cholesteatoma in the right ear.

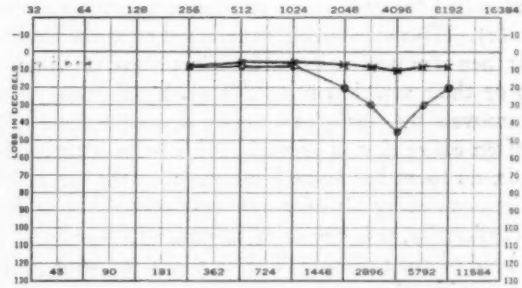

Fig. 5.—L. H. August 3, 1954. Audiogram showing improvement in the hearing approximately five weeks following right mastoidectomy.

been successfully treated by the operation described above. Following healing of the cholesteatoma perforation, the middle ear was treated by forcing medications through the drum perforation using the tragus of the ear as a plunger. It may be necessary to give attention to the eustachian tube to promote proper ventilation of the middle ear before healing of the perforation will occur. A report of the results of treating the large perforations in the drum, with more extensive middle ear disease, will be submitted later. This is done as a secondary procedure after healing of the cholesteatoma. At this time, the middle ear space and ear canal are made into one cavity. The eustachian tube is closed and the raw area skin grafted with a full thickness graft from the postauricular area.

It often happens that a surgeon describes a procedure with which he has had success, but others who try it are not pleased and cannot duplicate his results. This may well be due to a lack of detail in description and, hence, an inability to follow closely enough the original procedure. Therefore, I shall deliberately describe this procedure in detail.

The usual Shambaugh endaural incision is made with care to preserve intact the skin that lines the osseous ear canal (Fig. 1a, b, c). The mastoid antrum is entered with a perforating burr and the opening is enlarged with cutting burrs (Fig. 1d). The bony posterior canal wall is thinned and removed. The cholesteatoma is identified, isolated, and rolled forward to its attachment to the eardrum and ear canal (Fig. 1e). This attachment is referred to as the neck of the sac. This mass is then removed at its neck. Care is exercised not to disturb the ossicles or their attachments. All epithelial tissue and granulations are removed by fine picks under magnification. Excision of the sac is often easier if it is opened. This helps identify landmarks. In my hands, no harm has come from opening the sac as long as care is taken to remove every bit of visible epithelial tissue under magnification. Occasionally, it is necessary to remove tissue from the medial side of the head of the malleus. This can be done with proper instruments and magnification.

The bridge (that part of a rim of bone which holds the eardrum in its posterior and superior part) is removed (Fig. 1e). This relaxes the tissue surrounding the perforation and allows it to close. If this bridge is left intact, it serves as a guy wire holding the edges of the perforation apart making closure slower and much less likely. The incision in the ear canal is then closed with a fine curved-eye needle. I use a needle equivalent to a size #3 Lane cleft-palate needle. The suture used is 4-0 black silk. Six or seven small (about 3 mm in diameter) rubber sponges are left in the ear canal. These are satu-

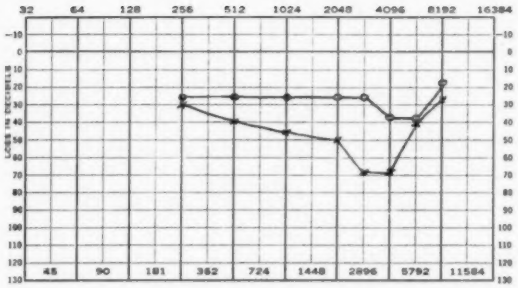

Fig. 6.—L. K. April 21, 1954. Audiogram before mastoidectomy showing bilateral hearing loss in patient who had bilateral cholesteatomata.

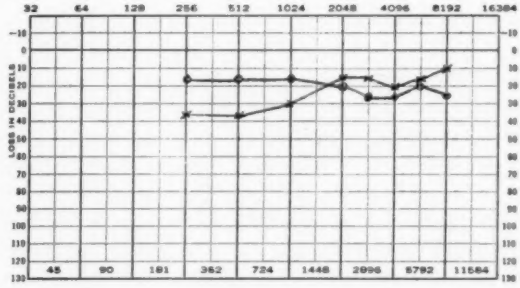

Fig. 7.—L. K. May 27, 1954. Audiogram showing improvement in each ear following bilateral mastoidectomy.

rated in penicillin solution, aqueous (200,000 units per ounce), and streptomycin (1 gram per ounce). The first sponges are removed on the third day and the last, on the fifth day. The sutures should be removed by the end of one week. After 24 hours, only cotton balls are necessary in the pinna because secretion is far less than with the classical procedure. The patients rarely require pain medication more than aspirin and that for only about 48 hours. In about 80 per cent of the cases, the ear is completely dry in two weeks. The other 20 per cent have usually dried in an additional week to ten days. I have found that one of the most important postoperative rules is to keep all instruments out of the ear canal and allow it to cleanse itself by serous discharge. Wiping with sterile applicators, suctioning and cleansing with forceps are only means of introducing infection and should not be used unless 1) the amount of discharge increases or 2) a foul odor develops. Satisfactory progress is indicated by a daily diminution in secretion. After discharge has been absent for one week, the ear canal is cleansed with Cresatin® (metacresyl acetate) and treated with 10 per cent boric water-soluble ointment. The ear is then left dry and re-examined at two-week intervals for a month. Then the patient is dismissed and asked to report in one year. Water is not permitted in the ear during the first year or until normal ear wax has formed.

On the initial visit, the maximum hearing loss found in cases of cholesteatomata with ossicular chain intact has been about 25 decibels. Many, of course, have no loss of hearing. Patients whose hearing loss approaches 40 decibels almost always have an interrupted ossicular chain and their hearing, as a rule, is not helped by surgery. The hearing occasionally improves markedly following surgery in cases without an incus. That is explained by some investigators as the fortunate coincidence of direct contact of the drum and the stapes and the correct tension between the two structures to promote optimum vibration. This is much the same as is seen in using the Pohlman prosthesis in a radical mastoid cavity. Hearing, after surgery in the majority of cases with an intact ossicular chain, has improved to within 15 decibels of normal or better.

The principal objection to the procedure is that one cannot observe the original location of the cholesteatoma after its removal because the ear canal has been reconstructed. This is mostly a fear of recurrence which might cause complications, an unnecessary fear in my opinion. If the hearing remains good, the middle ear and drum are normal in appearance, the ear canal is dry, and the patient is free of pain, the otologist need not worry about recurrence. The surgeon will not accomplish these four results with an incomplete excision of

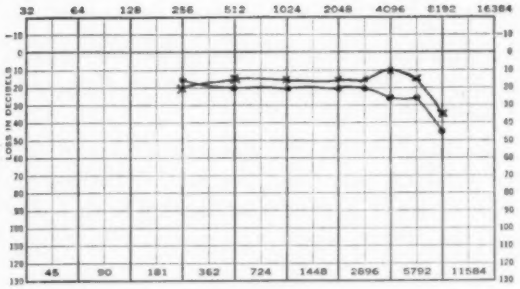

Fig. 8.—R. Y. May 19, 1954. Audiogram showing hearing loss in the right ear prior to mastoidectomy. The patient had a cholesteatoma on the right side.

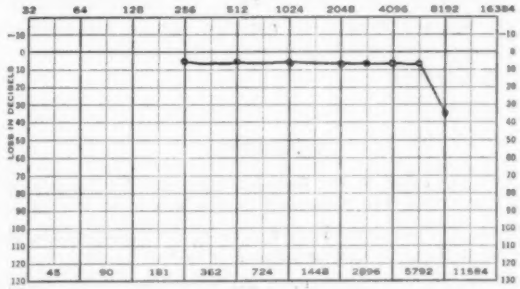

Fig. 9.—R. Y. June 2, 1954. Audiogram showing hearing improvement in the right ear approximately three weeks following mastoidectomy.

diseased tissue. Cholesteatomata are excised in many other locations in the body and the area of surgery closed. There should be no necessity for fear in a similar procedure here unless the surgeon is not satisfied that he has removed all the diseased tissue. In such cases, of course, the classical procedure is more desirable. This has not been necessary in my 25 cases.

Another objection is that the perforation may fail to close, but in 25 consecutive cases all perforations have closed spontaneously leaving the patient with a dry ear.

Nine cases have now been followed for a year and in no case has discharge restarted, pain begun, or further hearing loss occurred. This procedure is being presented in the hopes that many patients may be spared the cavities which were necessary in former years.

SUMMARY

A revision of the standard procedure for modified radical mastoidectomy is presented. Whereas the old procedure exteriorized the mastoid, the revision is a primary reconstruction of the ear canal after meticulous removal of diseased tissue. Thus far, it has been applied only in patients with cholesteatomata with the disease limited to the attic and mastoid and without suppuration in the middle ear.

The advantages of the procedure are: 1) quicker healing, 2) less pain, 3) no mastoidectomy cavity requiring postoperative care, 4) improvement of hearing when the ossicular chain remains intact.

DULUTH CLINIC

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XX

A CYST OF THE MASTOID

REPORT OF A CASE

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ALBUQUERQUE, N. M.

D.S., a thirty-four year old white female, once an active registered nurse prior to her marriage, was first seen at home by a local internist on May 16, 1953, complaining of sore throat, chills, fever and an oppressive malaise which had been intermittently recurring since March 1952. She did not feel like getting up in the morning and was tired early in the afternoon. She had several courses of sulfonamides, terramycin and aureomycin without permanent results. On a review of the systems by the internist mention is made of tinnitus, but not the ear in which it was located. A lymph gland was noted beneath a rather prominent left mastoid, and an increased sedimentation rate, normal BMR, negative chest x-ray and consistently low (2300 to 5250) white counts were determined. Bone marrow studies were normal.

The patient was admitted to the hospital for cervical biopsy on April 4, 1954, which showed a "mild reactive hyperplasia without evidence of malignancy or hyperplasia." She was then referred to an otolaryngologist who elicited a past history of "terrific nasal congestion" with a bout of pneumonia in England during 1944 and a subsequent left ear infection in 1946 with a recurrence in 1950 and periodic aural discharge since that time. The doctor ordered mastoid firms which were the first she had ever had and the radiologist felt that she had a cholesteatoma of the left mastoid. An antistreptolysin titer showed 255 units. (A titer of 50 units or more may be considered as evidence of streptococcus infection.)

I saw this patient in consultation with the otolaryngologist and internist. Fatigue and absent-mindedness were her chief complaints. Dancing made her dizzy; her hearing seemed to be perfectly normal, although her left ear had "discharged a few days previously." There

was slight tenderness over the left mastoid tip on heavy pressure. Her mastoid films were repeated in the Law and tip views, rather than lateral and stereo-Townes. The eardrums were apparently intact on both sides although there was faint evidence of a healed perforation on the left. Her audiogram for pure tones was entirely normal, at no time showing more than a 10 decibel loss in either ear by air or more than 25 decibel loss by bone in either ear.

The patient was admitted to the hospital on April 26, 1954, with diagnosis of left chronic mastoiditis, possible cholesteatoma and probably an old, left perisinus abscess.

A left simple mastoidectomy was performed by the postauricular route. As the mastoid cortex was removed a thin, yellow transudate was encountered and cultured. (*Beta hemolytic staphylococcus albus* was found.) As the cortex was removed a bluish, membranous, cystic structure, filled with a sanguineous material, was encountered and removed. It gave the appearance of being loculated and attached by a pedicle to intact mucoperiosteum on the bony cell partitions underlying the cyst. A possible site for drainage was encountered in the posterior canal wall where the skin was firmly adherent to a ragged area of bone. No evidence of attachment of the structure to the horizontal canal was noted. The cyst was not apparently extending through the aditus and the middle ear was uninvolved. An intact dural plate was found athough a surgical exposure was made in the region of the foot of the zygoma in determining the status of the middle ear.

A blood transfusion was given postoperatively and no antibiotics were used. Convalescence was uneventful save for one bout of dizziness and nausea, on the fourth day, which was attributed to a large dose of barbiturates.

The pathological description by Dr. H. V. Beighley follows: "Gross: The specimen consists of a cystic structure said to be removed from the left mastoid region. This cyst measures 9 mm in diameter. Contents had been emptied prior to arrival at the laboratory and the wall of the cyst is extremely thin and somewhat transparent. Microscopic: Fixed sections of the cyst show it to be lined in some areas by a thin layer of endothelial cells and in others by a fibrous connective tissue which makes up the wall of the cyst. Beneath the fibrous wall of the cyst there is connective tissue which is infiltrated with large numbers of chronic inflammatory cells, and focal accumulations of inflammation. Diagnosis: Large benign chronic inflammatory cyst of left mastoid."

To Dr. Andrew A. Eggston of the Manhattan Eye, Ear and Throat Hospital the section was sent for study. He writes as follows: "It appears that this is a cyst, lined with a single endothelial layer and surrounded by dense collagenous tissue. This is apparently dura or it could be periosteum. It is my impression this is a cystic endolymphatic sac. It is an unusual case. In any event, it is a simple retention cyst; I could find no other area from which it might arise outside of the endolymphatic sac."

On June 9, 1954, the antistreptolysin titer had receded from the previous 255 units to 10 units and the sedimentation rate to 35 mm in 60 minutes.

On September 7, 1954, the patient complained of some fatigue. She was considered by her internist to have some sort of rheumatoid disease, possibly lupus. I advised that the tonsils be removed, but the patient has not permitted this. When last seen she stated that she had some drainage from the ear, although no change was noted on the x-ray. There was no pain or discoloration of the postauricular scar and her operative myringotomy had been healed, apparently, at the time she complained of aural discharge.

COMMENT

A review of the medical literature of the past five years did not reveal a similar case to that presented.

Kopetzky[1] mentions cysts of the mastoid as being usually traumatic in origin and due to some injury to the blood vessels about the temporal bone (Jenkins). No history of trauma was elicited.

Bast and Anson[2] classify the otic (endolymphatic) duct system as including the otic duct with its distally placed endolymphatic sac, the utricular duct and saccular duct. Their text did not aid me in determining the developmental origin of the structure found at operation.

Ballance's monumental work on the temporal bone revealed nothing to clarify the operative situation.

Frederick M. Law[3] described a cyst of the mastoid, although his radiograph shows bony margins smooth and free of any crenellations like those pictured here. His case is briefly described: "The patient had no pain, slight tenderness and a serous bloody discharge for several months. There was a soft swelling over the side of the face just above the maxillary articulation; the superior canal wall was in apposition with the inferior. There is a punched out opening in the bone produced by cyst or operation." The history excluded previous

operation. "Operation showed a cyst located posterior and above the external canal. The cyst extended to the dura and when removed about five-eighths inch of dura was exposed. Another cystic area was discovered over the knee of the sinus and separated from the first by a wide bony partition."

Cysts are simply unilocular or multilocular cavities containing fluid and surrounded by definite walls. On the basis of origin they are usualy classified as retention, developmental cysts as arising from tumors or serous cavities, as parasitic or as pseudocysts.

The development of this cyst, whether inflammatory or endolymphatic, is uncertain. Coalescence of mastoid cells in unilocular form as the result of long-standing chronic inflammation could conceivably occur. On the other hand, the microscopic pathology is similar to the endothelium of the endolymphatic structure. This, coupled with the patient history of dizziness while dancing, suggests a possible labyrinthine origin.

CONCLUSIONS

This case suggests that an intact ear drum does not always indicate a normal ear. Roentgenologic study of the mastoids should be made of patients with vague symptomatology.

One must be constantly alert to the masking effects of antibiotics.

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XXI

HEMORRHAGE OF THE INTERNAL CAROTID ARTERY SECONDARY TO DEEP NECK ABSCESS

REPORT OF A CASE

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Bleeding from a large blood vessel in the neck as a result of erosion by a cervical abscess is an extremely serious problem. The importance of being alert to this complication, even in this antibiotic era, is underscored by two clinical facts: 1) Bleeding may be the first sign of an abscess hidden deep in th eneck and pointing into the pharynx or the external ear, 2) once bleeding occurs, if the blood supply to the involved vessel is not controlled, the patient will usually die.

REPORT OF A CASE

A 12 year old white boy was admitted to the Children's Hospital, Los Angeles, on April 23, 1953, with a three weeks' history of irregular fever as high as 105° orally and increasing swelling over the right side of the neck. Both of these signs appeared to follow a mild upper respiratory infection and sore throat. He was treated by his doctor with streptomycin (amount unknown) during the first week of illness and one injection of penicillin the day before admission. On the same day, the mass in the neck was aspirated by a second doctor with return of "foul pus." The patient lost nine pounds during the three weeks of his illness.

On admission he was thin, poorly nourished, with poor hydration, temperature 102°, pulse rate 130, respirations 24, and blood pressure 160/110.

There was a hard brawny mass on the right side of the neck extending from the right auricle and the mandible down to the clavicle and from the posterior cervical triangle anteriorly to the midline of the neck. There was possibly some fluctuation in the center. The head was turned to the left with the chin tilted to the

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right. The ears and nose were negative. The tonsils were large and diffusely pink but not acutely inflamed. The right hypopharynx was diffusely swollen and bulged medially. This swelling extended upward to involve the right side of the oropharynx to a lesser degree. The voice was weak. Mirror examination revealed a fixed right vocal cord. The right arytenoid was pink and diffusely swollen to three times its normal size. The tongue when protruded deviated to the left. The tips of both liver and spleen were barely palpable.

He was given terramycin 500 mgms intravenously immediately and 350 mgms every eight hours with approximately 1500 cc of intravenous fluids daily. Crysticillin 300,000 units was given every twelve hours and hot compresses were applied continually to the neck.

His course was febrile with a spiking temperature between 100.8° and 104° and a pulse varying between 100 and 135 for the first 48 hours. He was taken to surgery where, under intratracheal gas, oxygen and ether anesthesia, an incision was made posterior to the right sternomastoid muscle with liberation of 20 cc of frank pus from the deep tissues. This approach was chosen because it was in the region of greatest swelling and needle aspiration just before incision revealed underlying pus in this area. Following surgery, his temperature dropped markedly and stayed between 98.4° and 100.4° with a corresponding drop in the pulse rate. There was also a definite decrease in the hypopharyngeal swelling and the tilt of the head.

On April 26, two days postoperatively, there was a sudden spontaneous hemorrhage of bright red blood from the neck wound amounting to 100 cc which stopped as quickly as it started. The neck wound, which had ceased to drain, was then closed tightly with a 2-0 dermalon.

While his clinical course was generally better, x-rays of the neck on April 27 revealed marked increase in the size of the retropharyngeal, retrolaryngeal and retrotracheal tissues with reversal of the normal spinal curvature.

It was thought then that the incision and drainage had entered a portion of the abscess cavity only and further drainage was indicated.

On April 28, again under intratracheal gas, oxygen and ether anesthesia, an incision was made anterior and parallel to the sternomastoid muscle. As the sternomastoid and its investing fascia were reflected, a small amount of pus was found rising from the deep tissues at the level of the hyoid bone. These tissues were separated by blunt dissection to reveal a very thick-walled abscess cavity from

which 10-15 cc of pus were drained. In the depths of the cavity, which was found to extend under the mandible, there was a purple mass approximately 4 cm by 4 cm. As this was inspected, its friable wall gave way with a frightening gush of bright red blood. The blood flow was stopped by packing. Attempts to investigate the source of bleeding were unsuccessful because of the rapid flow when the packing was removed. With the pressure packing temporarily controlling the problem high in the neck, the incision was extended caudally to expose the right common carotid artery. This was then encircled by a rubber tape by which traction was applied to the vessel to stop the flow of blood. With this aid, we were then able to remove the packing and inspect the abscess cavity. On close examination, one could see a gaping hole on the anteromedial side of the internal carotid artery large enough to admit two fingers. The purple mass already described was an old blood clot which had formed a false aneurysm around the opening. As traction was released on the common carotid artery, blood was observed to pass out the opening in the internal carotid.

The right common carotid artery was then ligated with three separate 0 cotton ties. The abscess cavity was packed and the wound closed except for rubber wick drainage inferiorly and an opening for the packing superiorly. An elective tracheotomy was then performed and a Number 5 Jackson tube inserted.

During the operation 1000 cc of whole blood was given. At no time throughout the entire procedure did the blood pressure drop or the pulse rate rise significantly.

Postoperatively the patient was given 350 mgs terramycin intravenously in 10 cc normal saline solution every six hours, crysticillin 300,000 units and streptomycin 0.5 gms every twelve hours intramuscularly. He was able to take oral fluids on the first postoperative day.

The day following surgery a right Horner's syndrome was noticed in addition to the right X and XII nerve palsy noticed preoperatively. Both of these improved gradually thereafter. The pharyngeal and laryngeal edema subsided quickly.

The packing was shortened daily. On the 14th postoperative day, under general anesthesia, the final portion was removed, the lateral neck wound closed, the tracheotomy tube was removed and the tracheotomy wound was closed primarily.

Culture from the abscess cavity failed to grow any organisms. Hemolytic Staphylococcuc Aureus was obtained from the throat

smear. The blood counts were normal except for an initial leucocytosis of 35,500 with 89 neutrophiles. This had returned to normal at the time of discharge from the hospital on the 19th postoperative day.

COMMENT

This case illustrates some of the many complications produced by a neck abscess. There is evidence of phlebitis and sepsis, vocal cord paresis, tongue paresis as well as arterial erosion. It serves well to demonstrate the problems created when an infection spreads progressively along Mosher's "Lincoln Highway." We are concerned in this comment, however, with the specific complication, arterial bleeding, and shall dwell only on this one phase of the rather extensive picture.

Prognosis. Bleeding from a major vessel as a complication of deep neck abscess has always been a serious problem. If early and active therapy is not instituted, the possibility of a fatal outcome is overwhelming. In Salinger and Pearlman's[1] series there were 154 patients with bleeding complicating peritonsillar, retropharyngeal or parapharyngeal abscess on whom no surgery was performed. Of these, 114 or 72 per cent died. In the same series, of 73 similar cases in which ligation was performed, only 26 or 35 per cent died. These figures are even more startling when the cases of peritonsillar abscess are omited leaving only those of retropharyngeal and parapharyngeal abscess to be examined. One then finds that there were 51 such cases complicated by bleeding in which no surgery was performed. Of these only two survived!

In Lifshutz's[2] series of 23 patients, 19 died without surgery; of the four that survived, three were operated upon. These figures again emphasize the importance of early dynamic surgical intervention.

Post mortem examinations reveal that the vessel most commonly eroded is the internal carotid artery. Of 76 autopsies reviewed by Salinger and Pearlman,[1] the following vessels were found to be the source of bleeding:

Internal carotid	49	(19 false aneurisms)
External carotid	4	(1 false aneurism)
Common carotid	9	(3 false aneurisms)
Other vessels	14	

There are several anatomical reasons why the internal carotid artery is most often involved. 1) The internal carotid is the closest

to the pharyngeal wall which appears to be the most frequent point of origin; 2) this proximity may be aided by an aneurysmal dilatation or exaggeration of one of the curves normally found in the cervical portion of that vessel;[3] 3) the external carotid artery becomes smaller as it ascends in the neck.

The fairly high incidence of false aneurisms is interesting. It probably accounts for the fact that there may be several small episodes of sudden bleeding prior to the massive fatal one, a not infrequent aspect of the history in those cases reviewed.

Surgical Treatment. While the internal carotid is apparently the most frequently involved vessel, it is far safer and usually easier to direct surgical attention to the common carotid artery.

Of 51 patients of internal carotid ligation or transection described by Schorstein[4] and Rogers,[5] 12 had cerebral complications; of these, 8 died. On the other hand, of 43 cases of common carotid ligation or transection reported by Rogers, there was only one intracranial complication and no deaths. The difference in morbidity and mortality is so striking that if at all possible, surgical efforts should always be directed toward the common carotid artery, rather than the internal, when the latter is involved.

If the internal carotid must be ligated, Rogers advises first ligating the common carotid so as to develop collateral circulation through the circle of Willis which is a by-pass type of anastomosis and thus permits easy cross circulation. It would appear that this procedure has more to offer in a case where the time element is not so urgent as it is in the type of case under discussion. Rogers strongly argues for transection rather than ligation of the involved vessel. This decision is based on three factors: 1) The possibility of delayed embolism is reduced because the distal part of the vessel which may contain a clot at the site of ligation is not subjected to a pulse wave; 2) there is no possibility of recannalization; 3) transection severs the sympathetic fibers and completely abolishes spasm of the involved vessel. While there is no real indication for ligating the jugular vein in the cases under discussion, if the indication should arise, one should know that electroencephalographic studies revealing cerebral anoxia is increased if both the artery and vein are ligated at the same surgery.[6]

Incision and Drainage, External or Internal Approach? Our experience illustrates again that, whenever possible, it is most desirable to drain these deep abscesses externally. With this approach, one is in a more advantageous position for handling any complication which may arise. It is also wise at these times to make a very ade-

quate and, if necessary, extensive incision so as to permit thorough investigation of the problem at hand. Drainage of a cervical abscess by intraoral incision is extremely dangerous and should be the secondary choice of approach for all but peritonsillar and retropharyngeal abscesses.

Bleeding After Ligation. The distressing experience of having the bleeding continue after ligation (usually of the common carotid) will occur in some instances. This may be accounted for in several ways.

1. According to Dorrance,[7] ligating the common carotid artery will decrease the blood flow through the internal carotid only approximately 50 per cent; so if the erosion is in the latter vessel, the usual common carotid ligation may not be sufficient. This phenomenon is explained mainly by retrograde flow of blood down the ipsilateral external carotid and then back up the involved internal carotid. Dorrance has listed twenty authors who observed this unusual backward circulation. About one-half of this recurrent flow is reported to occur through the superior thyroid vessels.[8] Sweet and Bennett,[9] on the other hand, after studies at surgery which failed to demonstrate any retrograde flow, conclude that the collateral circulation all develops through the circle of Willis.

2. Ligation of the external carotid artery may arrest circulation through that vessel for only a short period of time. The circulation is re-established from the opposite side mainly through the thyroid vessels.[8] This problem may be overcome by ligating above the origin of the superior thyroid branch.

3. If the bleeding source is in the ascending pharyngeal artery, one must be aware of the anatomical peculiarities of that vessel. While in most instances it arises from the external carotid, it branches from the internal carotid in 5 per cent and separately from internal and external carotid arteries in 2½ per cent of cases.[8]

4. The continued bleeding may be from the internal jugular vein. This was a fairly common source in preantibiotic scarlet fever cases. It is extremely rare today.

SUMMARY

A case of erosion of the internal carotid artery by a cervical abscess is reported.

Problems relative to the treatment of this complication are discussed: Early surgical intervention to stop the hemorrhage is the

safest course; as a general rule, while the internal carotid is usualy the vessel involved, the common carotid should be ligated (and preferably transected); if surgical intervention is deferred the possibility of a fatal outcome is greatly increased.

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XXII

PRIMARY SQUAMOUS CELL CARCINOMA OF THE FRONTAL SINUS

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AND

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Cases of primary malignant disease of the frontal sinus are rare in the world literature. In 1940, Breeding[1] reviewed the literature and found 26 cases which he considered authentic cases of malignant disease, originating in the frontal sinus. He referred to Casteran and Achotegui[2] who reportedly found 37 cases and to Ringertz[3] who reported 19. He concluded, therefore, that 82 cases of primary malignant disease of the frontal sinus existed in the world literature provided that no duplication of cases occurred.

In our review of the literature since 1940, we have found a total of seven additional cases, reported as cases of malignant lesions arising in the frontal sinus. In only two of this number was the lesion confined to the frontal sinus proper.

In the majority of the cases reported, the lesion, whatever its histopathologic type, involved other sinuses or contiguous structures but in each case the frontal sinus was surmised to be the site of origin. The chief reason for this supposition was the fact that the bulk of the tumor lay within the frontal sinus. Although this may be a legitimate conclusion, it is subject to question.

The following case was selected from a group of 26 cases of malignant disease involving the frontal sinus encountered at the Mayo Clinic in the past 10 years. All but one were cases in which contiguous structures and other sinuses were involved by the lesion. This one case alone represents one in which the primary site is the frontal sinus, without equivocation.

REPORT OF A CASE

The patient, a 43-year-old white man, complained chiefly on admission of his genitourinary tract. He had had a 10-day episode

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of urgency, frequency, pyuria, pain in the penis and soreness in the right flank, one week prior to admission. For the last three months, he had had a continuous throbbing frontal headache, which at times was partially relieved by aspirin. He had lost 20 pounds over the past 6 months. Anorexia and malaise were included in his symptoms.

The family history was not contributory. The patient gave a history of the usual childhood diseases. In 1918, he had influenza. Tonsillectomy and "sinus surgery" were done in 1932. The nature and extent of the "sinus surgery" were unknown. In 1940, the patient had a bout of pleurisy. A review of the systems brought out the fact that his vision was impaired. He believed this to be a sequela of the operation on the sinus. Another purpose for his check-up was a dental and heart examination. He occasionally noted a "flutter" usually while lying in bed.

The physical examination revealed the patient to be a nervous, high-strung individual, whose vital signs were all within normal limits. A fluctuant swelling was palpable in the frontal area to the left of the midline. Eyes were entirely normal. Nasal examination showed mucus on the right, mucopurulent discharge on the left and the left middle turbinate was absent. The septum was deflected to the right side. Examination of the mouth revealed an edentulous upper jaw for which the patient used a prosthesis. The condition of the remaining lower teeth was poor. The nasopharynx, oropharynx and hypopharynx were essentially normal. No evidence of cervical lymph adenopathy was found. Examination of the thorax and abdomen disclosed slight tenderness of the right flank. One observer could palpate the left kidney. The rectum seemed normal. Laboratory findings were as follows: 12.9 gm of hemoglobin per 100 cc of blood, 12,300 leukocytes per cubic millimeter, normal urine, and negative serologic test (Kahn). X-ray examination of the thorax and head showed nothing of importance except a bridged sella and a smooth-appearing, sharply outlined defect in the anterior and posterior walls of the left frontal sinus. Stereoscopic roentgenograms of the sinuses revealed some marginal sclerosis in the defect. Diffuse clouding of all sinuses was noted with thickening of the membrane. The roentgenogram of the kidneys, ureter and bladder was obscured. Excretory urography revealed the right kidney and ureter to be normal. The left was too dimly visible to permit exclusion of a pathologic process.

The diagnoses were chronic posterior urethritis and osteomyelitis localized to the left frontal sinus.

On May 8, 1942, operation was performed on the frontal sinus. Through an external frontal approach, the lesion uncovered measured

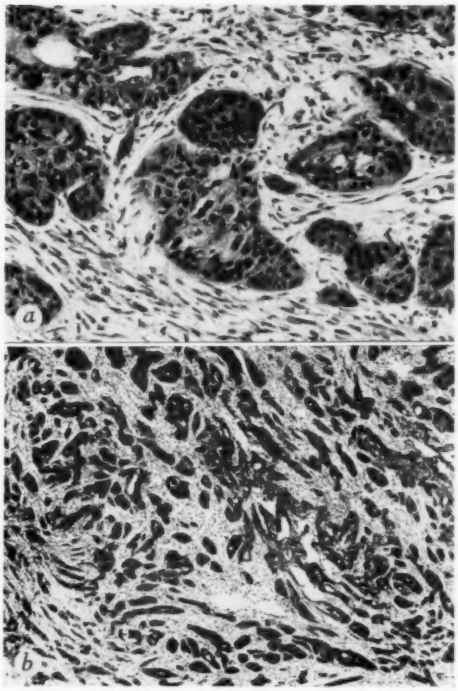

Fig. 1.—Squamous cell epithelioma, grade 3, of the frontal sinus. Intercellular bridges and cells containing keratin should be noted (hematoxylin and eosin).

one inch in diameter and grossly appeared to be a neoplasm or gumma. Fresh frozen section of the lesion revealed squamous cell epithelioma, grade 3 (figure). The posterior wall of the sinus was perforated by the lesion, so that the overlying dura was involved as well. The malignant mass was removed and the dura was permitted to remain intact; four 50-mg platinum tubes of radium were placed. This procedure resulted in a cosmetic defect of the forehead which would be corrected by subsequent plastic procedures.

The immediate postoperative course was uneventful. The patient has returned to the clinic many times for corrective procedures. This has afforded ample opportunity for repeated examinations for recurrence which to date has not been found.

Cranmer[4] reported on 91 cases of malignant neoplasms of the paranasal sinuses. All but 17 patients had two or more structural

COMMENT

entities involved. Of these 17, no mention of frontal sinus involvement alone was made. Winborn[5] in his treatise on malignant disease of the nose and sinuses reported 26 cases. Of those, in which the frontal sinus was involved, he said, "The lesion originated elsewhere in the nose or represented a basal cell epithelioma which had eroded through from the skin."[6] Many other studies of primary malignant disease of the paranasal sinuses in the literature attest to the fact that more than one sinus is already involved when the patient is first seen. The problem of early diagnosis in this disease is a great one. Furthermore in these situations, determination of the primary site of origin can at best be surmised, never proved.

Our case has several interesting features. In essence it represents an early malignant process, discovered as an incidental finding. True, the lesion was responsible for the swelling of the forehead and the headaches. It undoubtedly accounted in part for the anorexia, loss of weight and malaise. Nevertheless the primary complaint had to do with the genitourinary system. Had it not been for the latter, the patient would have delayed seeking medical aid, which would have lent to progression of growth and local extension. It is the early diagnosis and localization of the lesion that place this case in its unique category.

The fact that the tumor in this case had eroded both tables of the frontal sinus brings up the question of contiguous spread. Since the dura was exposed and involved by the tumor posteriorly and the subcutaneous soft tissue anteriorly, the possibility of the tumor arising from either of these sites must be considered.

With respect to the former, a meningioma could plausibly arise from the dura and occupy the frontal sinus. It is known also that certain meningiomas closely simulate squamous cell carcinoma microscopically. Whereas in meningiomas, the cells are uniform in size and shape, occur in nests and are arranged in whorls and the characteristic psammoma body is seen frequently, intercellular bridges and cells containing keratin are never seen. The latter characteristics plus pleomorphism characterize the tumor tissue in this case as squamous cell epithelioma (Fig. 1). The tissue sections from this tumor are positively identified as the latter by Drs. MacDonald and Woolner of this clinic.

If this tumor had arisen in the skin overlying the frontal sinus, superficial necrosis, ulceration and the like would be manifest long before penetration of the tumor into the sinus.

Brunner[7] reported a case of osteogenic sarcoma of the frontal bone in which sclerosis of bone was the salient roentgenologic feature. In discussing this finding, he pointed out that the characteristic roentgenologic finding in primary carcinoma of the paranasal sinuses is erosion and destruction of bone, often accompanied by secondary osteomyelitis. This finding was true in our case.

The patient although lost to follow-up at present was alive and well 12 years after operation. This indicates that simple excision of the tumor plus implantation of radium alone effected a cure.

SUMMARY

Authentic cases of primary malignant disease of the frontal sinus are rare. A total of 90 cases, including the case reported herein, has been found to date in the literature. The fact that the tumor in the case reported was confined to the frontal sinus is attributed to the early diagnosis of the tumor as an incidental finding. Roentgenologic features of the lesion are consistent with those usually produced by primary carcinoma of the paranasal sinuses and the osteomyelitis contributed to the failure to make the diagnosis before operation. Treatment by surgical excision and implantation of radium effected a cure.

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XXIII

PRIMARY LYMPHO-EPITHELIOMA OF THE NASOPHARYNX

ALAN L. ROWLAND, M.D.

SAN DIEGO, CALIF.

REPORT OF A CASE

T. J. McK., a 69-year-old white man, was first seen on January 23, 1952. His complaints were of a very minor nature: a slight fullness of the left ear of any three days' duration and a small diminution of hearing in the same ear. He had first noticed these symptoms not earlier than three days before and prior to that he had been entirely well. There were no other complaints and the patient stated that he thought he was "due for washing out of the wax" in his ears. He complained of no pain or distress of any kind. He stated that he had been a street-cleaner in New York City for many years and that he had "not had a sick day in his life." He had had no disease or symptoms at any time referable to the ear, nose or throat. The hearing was within normal limits for spoken and whispered voice, tuning forks showed normal responses, and an audiogram done the next day showed a curve normal for the age of this patient, with a maximal decrease of about 10 decibels above 4096 dv. There was no cerumen present. The external canals were slightly larger than normal. There were no scars on the tympanic membrane, and all landmarks were normal. There was a very slight retraction of the left drum but this was freely movable.

The septum was slightly deflected to the right but there was no obstruction of the airways and the turbinates were not enlarged or of abnormal consistency. There was no discharge from the nose or the sinuses. The nasopharynx was essentially normal at this time. In short, the nose presented no apparent abnormality.

A slight enlargement of the superficial cervical lymph node was felt at the left angle of the jaw. This was freely moveable above and below and seemed to have a regular surface smoothness, but was slightly larger and somewhat firmer than the gland on the right side. It was this finding when combined with the patient's complaint of

fullness in the left ear, his age, and the slightly more marked tenderness of the glands of the left side of the neck which seemed suspicious of possible malignancy.

The tonsils had been removed. The fauces were normal. The only suspicious finding was a slight bulging and swelling in the left tonsillar fossa. The patient did not complain of sore throat and there was no abnormal redness or injection of the pharyngeal mucosa.

The eustachian tubes were patent. However, it seemed, on this day of the first examination that there was a faintly higher pitch to the tone of the insufflated air on the left side.

Despite the minor nature of the complaints, after one or two treatments and insufflations a tentative diagnosis of possible malignancy of the nasopharynx was made. The patient was sent for x-ray. Preparations for biopsy were undertaken to rule out malignancy.

Report of x-ray on January 28, 1952 was as follows:

"Axial view of the skull: There is definite soft tissue increased density involving the left side of the nasopharynx. No bone destruction is made out in the base of the skull.

Soft tissue of neck: There is no evidence of displacement of the trachea or of soft tissue thickening in the region of the hypopharynx. There are minimal hypertrophic changes involving the bodies of the cervical spine.

Chest: No metastatic changes are seen in the lung field. The cardiac shadow is not remarkable. There are moderate hypertrophic changes involving the thoracic vertebrae.

Conclusion: Soft tissue density in the region of the left side of the nasopharynx.

No metastatic skeletal changes are seen in the base of the skull.

No evidence of pulmonary metastasis.

I believe that this patient should have a thorough examination of the nasopharynx and a biopsy of one of the peripheral lymph nodes."

On January 30, 1952, biopsy was done of a small amount of tissue removed through a small incision made parallel to the anterior margin of the sternocleidomastoid muscle.

A tentative diagnosis was: anaplastic carcinoma, or so-called metastatic lymphoepithelioma of the cervical lymph nodes.

The patient seemed to have recovered. He stated that his ear felt better and that he thought he should be discharged, as he had no further complaints referable to the ear or throat. However, on insufflation on February 4, 1952 it was felt that the eustachian tube was slightly less patent than it had been three or four days before. Also the nodule below the angle of the jaw seemed slightly firmer and so the patient was prevailed upon to allow another biopsy of the suspected tissue. The patient assented. On February 5, 1952 a frozen section was made. This report confirmed the biopsy report of January 30, 1952.

"Gross: The specimen consists of two irregular firm, friable reddish-tan pieces of cervical lymph nodes measuring 2.5 cm and 1.3 cm, respectively, in the longest dimension.

Microscopic: The section shows a very anaplastic malignant tumor. The tumor cells are situated individually in a very sparse stroma. The cells are large, contain large vesicular nuclei with prominent nucleoli. Mitotic figures are frequent. The cells are approximately four or five times as large as the small lymphocytes which are present in the lymph node.

Diagnosis: Rapidly growing anaplastic malignant tumor, probably a so-called lympho-epithelioma, which has metastasized to the cervical lymph nodes.

Note: Because of the clinical history of the onset symptoms being referable to the area of the eustachian tube, and the site of the present biopsy in the cervical region, and also the morphologic character of the tumor, I believe that the most logical diagnosis is a so-called lympho-epithelioma or better—an anaplastic carcinoma originating in lympho-epithelial tissue of the nasopharynx. From the morphologic characteristic of the tumor, I feel that it should be radiosensitive."

The patient was at once started on a course of deep x-ray therapy, the first part of which was completed April 2, 1952. The report from the roentgenologist follows:

"We have completed the course of x-ray therapy to Mr. T. McK. whom you referred to us with a diagnosis of lympho-epithelioma in the left nasopharynx with metastases in the left upper neck, behind the angle of the mandible.

From 2-8-52 through 4-2-52, the right and left anterior maxillary fields were treated. The left field was directed straight in and the right field was directed medially 20 degrees in order to cross-fire the left nasopharynx posteriorly. A total of 3,000 r, air, was given to each field. The field size in each case was 5 x 5 cm. From 2-7-52 through 3-31-52, right and left lateral maxillofacial fields were treated, each field received 3,000 r, air. With respect to the right lateral field, the field size was 12 x 10 cm. On the left side, the site of the lesion

and metastases, initially a field size of 13 x 10 cm was used, in order to include the metastatic lesion. This was subsequently decreased to 9 x 8 cm and coincidentally with this a separate field over the metastatic lesion was given treatment. Thus, for approximately half the treatment period in the left lateral maxillofacial field, there were actually two areas given treatments, a 9 x 8 field over the primary lesion and a field 6.5 x 6.5 cm over the metastatic focus. The dose both to the field over the primary lesion and to the metastatic focus was 3,000 r, air.

The technical factors in all cases were 250 KV.P, 15 ma, 0.5 mm cu plus 1.0 mm al added filtration, 70 cm distance.

In general Mr. McK. tolerated the treatments extremely well. He developed a fairly early skin reaction which leveled off and did not become progressive. We do not anticipate any definite difficulty with this reaction which should be reaching its peak in two to three weeks. The usual complaints relative to the mouth and the impaired sense of taste, together with sore throat, were present. These had been explained to Mr. McK. in advance and were a natural result of therapy of this type. Mr. McK. did complain of some difficulty with respect to soreness around the left upper posterior molar which remains. This is undoubtedly associated with a radiation reaction and a poor tooth. It may well be that in time this tooth may have to be removed, but it would be extremely precarious to consider extraction at this time until the radiation reaction has fully subsided. This has been explained to Mr. McK. as well.

This prolonged and intensive course of deep x-ray therapy has been designed to deliver a tumor dose of between 6500 and 7000 r in the primary lesion in the left nasopharynx. To date the response has been excellent. We can only hope that with the passage of time Mr. McK. will continue to make satisfactory progress. We have asked him to return in one month in order that we may evaluate his status after the peak of the reaction has been passed."

During this time the patient continued to be seen at the author's office. The eustachian tube continued to increase in patency, the patient had no complaints and on March 18 it was found that he had gained 2½ pounds since beginning treatment. He had no anorexia and felt well. The slight bulging underneath the intact and normal mucosa of the left fossa had disappeared completely and there were now no abnormal clinical findings present. On May 15 it was found that he had gained another 1½ pounds. A blood count was done on May 22 and showed: red cells 5,950,000, hemoglobin 85%, white cells 3,950.

He continued to feel fine until July 17 when he complained of a vague stomach discomfort. He was immediately sent for x-ray and general surgical consultation in view of the potential seriousness of the situation.

X-ray report on July 17, 1952 was as follows:

"Stomach: In the preliminary film, no abnormal densities are seen. There is some calcium in the prostate. Fluoroscopically the esophagus is not remarkable. The mucosal pattern of the stomach is coarse. The duodenal cap is markedly deformed in a cloverleaf fashion. A definite crater is not seen.

Conclusion: Deformed duodenal cap, typical of a duodenal ulcer."

A surgical examination was made by a senior attending abdominal surgeon and the report was that the ulcer could be treated medically in view of the good general condition of the patient, and that exploratory laparotomy was not necessary.

The patient seemed to respond favorably, the general condition became satisfactory and progress was good until on October 28 there was a sudden worsening of the patient's abdominal pain and immediate steps were taken for abdominal exploration which was done October 29. During this time both the author and the radiologist had kept the patient under periodic observation in regard to the nasopharyngeal and cervical condition and this continued to appear normal in every respect, the radiologist not considering it necessary or beneficial to give the patient another course of deep x-ray therapy to the neck.

A biopsy report on October 29 after laparotomy read:

"Gross: The specimen consists of an irregular fragment of tissue measuring 2 x 1.5 x 1.5 cm which is revealed to be two firm, gray-tan nodules, the larger measuring 1 x 0.8 x 0.5 cm the smaller 0.8 x 0.5 x 0.5 cm. On section the tissue is homogeneous, gray-tan and firm except in the central portion is necrotic. Representative sections are taken.

Microscopic: Sections of the omentum show it to be diffusely infiltrated with very anaplastic tumor cells. The predominant cells present a pleomorphic vesicular nucleus with a scanty amount of eosinophilic cytoplasm. They infiltrate throughout all the omental tissue received and almost completely replace the adipose stroma. The morphology of the malignant cells is compatible with that present in the previous biopsy from the cervical area on February 5, 1952.

Diagnosis: Metastatic malignant tumor, probably a lymphoepithelioma, which has metastasized to the omentum.

Note: This tumor should be very radio-sensitive."

Progress from this date onward was steadily downhill.

The patient died January 10, 1953.

Primary malignant tumors of the nasopharynx are comparatively rare. Martin and Blady[1] report 2% of all malignancies seen in Memorial Hospital, New York City. But of these, primary growths are a small part. Hartley and LeStrange, at the San Diego Naval Hospital, report that of about 50,000 routine, surgical tissue examinations there have been only four cases of primary lympho-epithelioma of the nasopharynx[2] seen in eight years.

Raven[3] states that these effects are maximal because of the rapid onset of interference with respiration and deglutition which may

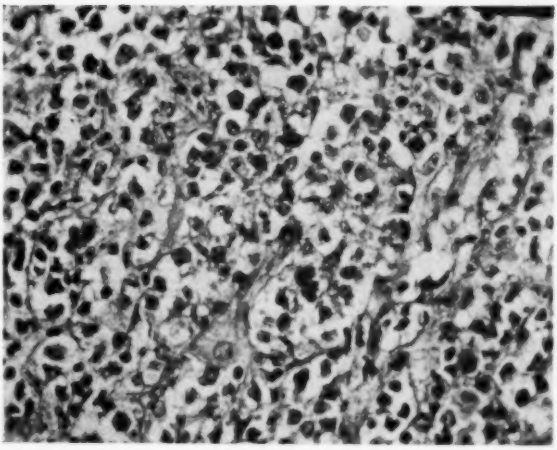

Fig. 1.—Primary lympho-epithelioma of the nasopharynx (X500). January 30, 1952.

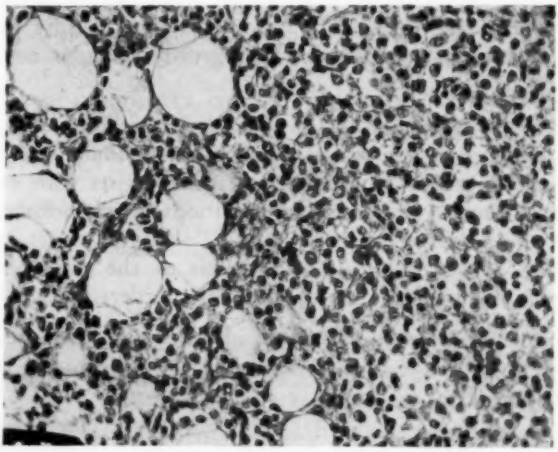

Fig. 2.—Metatasis to omentum, of primary lympho-epithelioma of the nasopharynx shown in Figure 1 (X300). October 29, 1952.

occur. The number of cures is very small. I have found that the percentage of five year cures reported is about one of every five cases of lympho-epithelioma diagnosed *early* and fully treated.

Lederer[4] classes primary lymphoepithelioma under mesopharyngeal tumors. Of the malignant growths, the more anaplastic forms (of which the case presented is one) of carcinoma and sarcoma are fairly common.

The regional lymph-nodes in the carotid triangle are affected early. Some classify these as tumors of the hypopharynx. Here they are usually of an undifferentiated character and highly malignant in their progress. Willis[5] states that "while tumors of any structural variety may occur in any part of the pharynx or fauces, particular variants predominate in particular situations." In the nasopharynx the so-called lympho-epitheliomas and transitional-cell carcinomas predominate. Willis also states that "the commonest site of nasopharyngeal growths is in the lateral wall close to the eustachian orifice, so that unilateral deafness is an early symptom."

The early symptoms are vague, minor and indefinite. Morrison[6] puts it well. He states that "cancer of the nasopharynx is especially insidious and the lesion frequently causes no symptoms." The chief early symptom is usually some form of discomfort in the throat and ear, such as slight pain on swallowing or local irritation of the throat or ear. It is unfortunate that, as in the author's case here reported, the symptoms and signs may be so vague as to resemble "globus hystericus" or "anxiety neurosis." It can easily be said of some of these early cases that patients greatly resemble neurotics or malingerers.

What is more important, is that, at its earliest stages at least, this condition greatly resembles many more common and more benign conditions which are seen by otolaryngologists with very great frequency. Among the common conditions which primary malignancy of the nasopharynx may resemble are pharyngitis, tonsillitis, nasal and pharyngeal allergy and stenosis of the eustachian tubes. Therefore it is imperative that a very early differentiation be made.

Biopsy, with positive pathologic identification (often confirmed only after several have been done) is the only diagnostic procedure of any value.

The case here presented unfortunately proves that very early diagnosis does not insure success, and that even competent consultation is often relatively futile. All that can be hoped for at present is the earliest differentiation, diagnosis and treatment, so that as much

symptomatic relief as possible may be effected, and an occasional cure obtained.

Treatment of lymphoepithelioma of the nasopharynx is unquestionably not surgical although Raven[3] has advised extensive bilateral block dissection of the lymph nodes of both sides of the neck leaving the internal jugular vein and the sternomastoid muscle on the side where the lymph nodes are smaller. Kean[7] states that "surgery should be limited to the performance of a biopsy, preferably by the endotherm knife. External radiation, either by x-rays, or by teleradium is the method of choice." Martin[8] expresses a similiar opinion. He believes that surgical treatment alone has met with little success in dealing with tumors of the upper pharynx. Trotter's advice[9] is well worth heeding when he says "for the surgeon, the pharynx combines three of the most formidable obstacles to the exercise of his art. It is inaccessible to a high degree, it is the seat of delicate and concentrated function and it contains septic material to which the surrounding tissues are in no way immune." Finally, Morrison[6] states his opinion categorically. He says that "operation is of no value. An adequate course of radiation therapy is the only form of therapy that can be advised.

"The number of reported five-year cures is so small that therapy is essentially palliative. However, the fact that there are some cures makes it imperative that all cases receive intensive radiation. These tumors are very radio-sensitive." Morrison's is a point of view with which the author thoroughly agrees.

SUMMARY

A case of primary lympho-epithelioma of the nasopharynx is presented. The value of early diagnosis and treatment has again been stressed.

625 BROADWAY.

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XXIV

A NEW INFANT TRACHEOTOMY TUBE

PAUL H. HOLINGER, M.D.

CHICAGO, ILL.

This tracheotomy tube has several new features designed to facilitate the management of tracheotomized infants. The plate is small, approximately ½″ x 1″, and it is rigidly attached to the outer tube to make the plate and outer tube a solid unit. The angle of attachment between plate and tube is 65°. This was chosen to conform to the skin-trachea angle of infants as determined by lateral x-rays

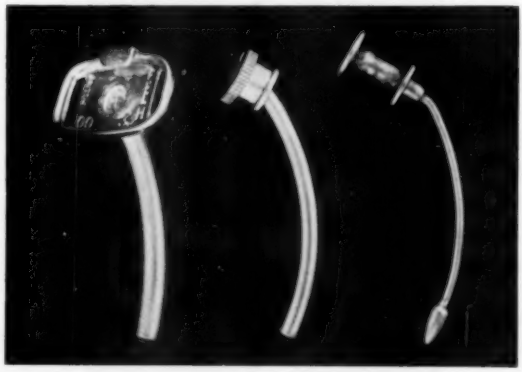


Fig. 1.—New infant tracheotomy tube, size 00, 33 mm length. Inner tube, outer tube and plunger demonstrate the curve and the plate-tube angle.

of the neck. The plate contains the conventional slots for the ribbons. The inner tube lock consists of a knurled knob similar to that of the C. L. Jackson tracheotomy tube. The lower flange of the knob locks under a lip which extends from the edge of the plate. Both upper and lower flanges of the knob have one straight edge; the lower to permit the flange to slide under the lock, the upper to indicate more readily the position for locking and unlocking the

inner tube. The groove on the face of the knob further indicates the "unlock" position. The inner tube opening in the knob is counter-sunk, key-hole manner, to facilitate introduction of the catheter.

This infant tracheotomy tube is obtainable in sizes 00, 0 and 1. Each size is made in short, medium and long tube lengths, 33, 40 and 46 mm, respectively.

These tracheotomy tubes are manufactured by the George P. Pilling & Son Co., Philadelphia, Pa.

700 N. Michigan Ave.

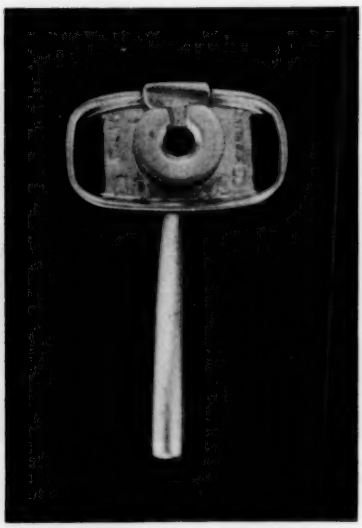


Fig. 2.—Detail of plate, lock and inner tube knob.

Society Proceedings

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

Meeting of Monday, March 7, 1955

THE PRESIDENT, DR. NORMAN LESHIN, IN THE CHAIR

An Audiologic and Otorhinologic Evaluation of Cleft Palate in Children

MURRAY M. HALFOND, M.D.

AND

JOHN BALLENGER, M.D.

(Abstract)

In an attempt to learn more about the relationship of cleft lip and cleft palate hearing loss, 69 cleft lip and cleft palate persons between the ages of 8 and 21 years were examined audiologically and otorhinologically. The cases were divided into two groups on the basis of the presence or absence of hearing loss. It was found, however, that the group of cleft lip and cleft palate cases without hearing loss had minor auditory deficiencies that precluded labeling this a "normal hearing" group.

Further audiologic analysis revealed that the group with hearing losses had mild to moderate conductive-type losses with preceptive-type elements in some cases. Analysis of the audiometric contours of the conductive components of the hearing losses showed five basic patterns could be evolved. Whether these conductive component patterns were typical of this group, all cleft lip and cleft palate persons with hearing loss, or persons with conductive-type hearing losses, could not be determined. The conductive component audiometric patterns in the group without hearing losses were flat, but showed similar contours of less magnitude to the hearing loss group. In both groups, differences between right and left ears were insignificant.

The otorhinologic evaluation indicated that active middle ear pathology, ear drum scarring, tonsillar pathology (both past and present), small eustachian orifices and abnormal tubal patency were related to hearing loss in this population. Variables such as middle ear fluid, ear drum perforation, adenoid pathology, velar and pharyngeal mobility, oversized turbinates, deviated septums, frequency of upper respiratory infection were not related to hearing loss. However, when the combined frequency of structural and pathologic stress to hearing were compared, a significant difference was found between the two groups. Therefore, it appeared that some variables contributed to the hearing loss in some cases and not in others. It was apparent in the study that the differences between groups were differences in degree rather than in kind.

Results of this study suggested that the hearing problems of the cleft palate and cleft lip persons need more extensive attention clinically. For the speech therapist and audiologist, the implications were that these hearing losses would not interfere with speech development but might interfere with the precision of speech production. Speech therapy methods must necessarily be adapted to the hearing loss with greater use of visual, kinesthetic and tactile training methods. The severity of hearing losses also indicates the need for speech reading in the regular class room. Hearing aids, auditory training and special schools would not be required.

The implications from this study for plastic surgery are the need for greater care of the cleft lip and the cleft palate patients in order to reduce to a minimum all structural abnormalities and further study of surgical technique to insure less damage to structures related to the ear. The need for inclusion of the otologist on the cleft palate rehabilitation team is important. In that way, all auditory deficiencies and otorhinologic pathology can be investigated in order to forestall or limit hearing loss.

This study served to point out the need for more careful consideration of the audiologic-otorhinologic problems that are often related to the cleft lip and cleft palate handicap in order to secure more adequate rehabilitation.

DISCUSSION

DR. JOHN BALLENGER: It would appear to me that the next step in an investigation of this sort would be concerned with the function of the eustachian tube. In man, the eustachian tube has no good functional test. The pneumophone designed by van Dishoeck is helpful but not entirely reliable. Use of this was made in

this study, although the report has not been given in the abstract as presented. We need an eustachian tube function test that is reliable, and if we had that we could control the findings both in cleft palate and in other ear disease. It is hoped that further research will provide more reliable tests.

DR. EMANUEL SKOLNIK: It is gratifying to know that Dr. Halfond's findings were similar to those we have found at the University of Illinois. About 45 or 50 per cent of the children did have hearing abnormalities. We have been convinced that the adenoid has an important function. We have seen many cases that have been repaired and, when the adenoids have been removed, the speech defect was greater. I am wondering if you are concerned, as we are, about adenoid tissue, and I wonder if you would elaborate on your findings relative to adenoid tissue.

DR. MURRAY M. HALFOND (closing): With reference to removal of adenoids in cleft palate cases as a threat to hearing: this is recommended on the basis of my observation and clinical judgment. Where there is pathology, removal may be advisable. So far as the lymphoid tissue about the eustachian tube is concerned, I do not feel qualified to say whether or not that might be best to do.

The nature of the examination was of great concern to us; how we were going to measure deviations and how to treat the information we obtained. After careful consideration we knew of no better way to handle these examinations. Out of this we established a research approach in which we would consider only gross deviations, ignoring small deviations that might have no bearing on our cases. I would certainly grant that there were limitations to our findings, but most of the recommendations suggested I think have some application. This we hoped would stimulate more research and, with more study of cleft palate cases we might have a better understanding of the problem.

Orbital Mucoceles

HANS VON LEDEN, M.D.

(Abstract)

Orbital mucoceles originate in the frontal or, occasionally, in the ethmoid sinuses. Obstruction of the nasofrontal duct (or of an ethmoid cell) is followed by inflammatory changes in the mucous lining of the affected sinus and collection of mucus in the obstructed cavity.

The increasing pressure gradually erodes the bony orbital wall, with herniation of the cystic tumor into the orbit. Due to their insidious development, mucoceles often remain undetected until the orbital mass displaces the eyeball, causing visual changes.

The diagnosis of an orbital mucocele is based upon: 1) a thorough ear, nose and throat examination which shows a firm swelling along the superior orbital rim, and usually also obstruction of the nasofrontal duct; 2) complete eye studies which generally indicate proptosis of the involved eyeball, limited motion of one or more eye muscles, and diplopia with or without impairment of visual acuity, and 3) roentgenograms revealing cloudiness of the involved sinuses and destruction of the bony orbital roof.

Treatment consists of careful surgical removal of the diseased structures by an external approach and restoration of a patent nasofrontal passage. This may be maintained by the insertion of a large tantalum prosthesis which can safely be left in place for several months without any discomfort.

The differential diagnosis includes all neoplasms of the orbit. The latter show no clinical signs of sinusitis, no roentgenographic evidence of sinus disease and no destruction of the bony orbital roof. Surgical exploration confirms the diagnosis of an orbital tumor and permits its complete removal.

Early diagnosis of orbital mucoceles and prompt indicated surgery avoid the permanent impairment of vision and the grotesque appearance commonly observed in late cases.

Clinical Application of Automatic Audiometry

RAYMOND CARHART, M.D.

(Abstract)

Now that automatic audiometers are becoming commercially available at moderate cost, the clinician must become aware that the methodology employed in automatic audiometry can have a substantial effect on the test results. One would expect that some patients would find it difficult to manipulate an automatic audiometer. More basic is the fact that the level at which even a normal hearer traces his threshold can be modified significantly by the nature of the stimulus. The span between the peaks and valleys of the tracing can be sharply reduced by slowing up the rate at which the stimulus intensity is allowed to fluctuate. Again, the threshold for a tone which is interrupted by rest periods of about a second can be

10 decibels better than the threshold for the same tone when presented continuously. Finally, the normal adaptation of the ear to a previous listening situation may modify the thresholds for continuous tones by another 10 decibels. These factors indicate the need for a standardized technique of automatic audiometry which will reduce those variables that can be controlled and which will furnish clinicians with a firm basis for exchanging findings.

DISCUSSION

DR. ROBERT HENNER: I would like to know if Dr. Carhart has had any experience with differential diagnosis between conduction hearing loss and nerve deafness. What little experience I have had gives me the impression that the conduction deafness threshold is more difficult to establish than perceptive deafness. It might be that with mixed deafness it would be possible to define the degree of nerve involvement by the breadth of the tracing.

DR. RAYMOND CARHART (closing): We have not attempted to use automatic audiometry in clinical work. We have used it only for research. Therefore I can answer only what is in the literature. There are many people, from Europe particularly, who claim that the spikes are much larger when the lesion is neural than those obtained if the lesion is of cochlear origin. They feel that differential diagnosis can be made on that basis. However, it is true that there are individuals with completely normal hearing who have spikes so small that they would have to be classified as having cochlear pathology if the aforementioned principle were invoked. Thus, it seems to some of us that the whole question needs additional clarification through research.

Relation Between Size of Fenestra and Hearing Improvement in Fenestration Surgery

GEORGE E. SHAMBAUGH, JR., M.D.

AND

JORGE GARCIA GOMEZ

(Abstract)

The possible relationship between size of fenestra and resultant hearing was investigated by Rytzner at Northwestern University in 1954 by means of pure tone hearing tests at various stages of the fenestration operation. This well-controlled and careful study revealed no significant improvement in hearing during the fenestration operation until the beginning of the actual fenestra opening. At

the first tiny fracture of the last layer of bone the first small gain in hearing occurs averaging 2.1 db for the speech frequencies. With removal of the endosteum from this opening there is a slight further gain. As the fenestra is enlarged to full size with removal of the endosteum the hearing improves considerably to 12.26 db above the preoperative level. Since these measurements were made with the fenestra and middle ear opening not yet covered by the flap they are not comparable to the situation in the healed fenestrated ear.

To investigate the possible influence of fenestral size on hearing improvement in the healed ear, 311 consecutive cases of ideal suitability were studied, operated on by two surgeons. The size of the completed fenestra, measured at operation, varied from 2 mm^2 to 3.6 mm^2 the width varying from .75 mm to 1.2 mm as measured with the fenestrometer. Four groups of cases were studied, 100 operated on by surgeon A, tested six months after operation; 57 operated on by surgeon B tested six months after operation; 100 operated on by surgeon A tested two years after operation, and 54 operated on by surgeon B tested two years after operation. In all four groups the smaller size fenestra yielded a slightly lower percentage of cases at the 30 db practical level than the medium and large fenestras. Surgeon B, whose fenestras averaged somewhat larger than those of surgeon A, had a slightly higher percentage of cases reaching the practical level.

The failures in this series of 311 cases were studied. No consistent relationship was found between size of fenestra and incidence of closures which totalled six, or in the failures due to serous labyrinthitis, which totalled three. To further investigate the possible relationship between size of fenestra and degree of postoperative labyrinthitis, the two-week hearing tests and the two-week tests for the 4096 frequency alone were studied and no consistent difference was found in the average hearing gain or loss for the different sizes of fenestras.

In conclusion, the authors suggest that there is a very definite relationship between size of fenestra and hearing result. The optimum size seems to be about 1 x 3 mm with a total area of 3 mm^2 which approximates the average size of the oval window.

DISCUSSION

DR. ROBERT HENNER: As a surgeon practicing fenestration I have given some thought to the problem and think it important to have had these results presented at this time. It would seem extremely difficult to predict what the ultimate size of the fenestra would be, because in every operation some closure must occur. I

would say that the larger the fenestra the better. It is impossible to widen more than 2.5 - 3 mm without causing projection of the membranous canal. Physically, it would seem that the larger fenestra would have more capability of transmitting tones of lower frequency. These results were all of higher frequencies than would be affected by smaller fenestras, and therefore it is difficult to compare the results.

DR. GEORGE E. SHAMBAUGH, JR. (closing): Dr. Henner has made two excellent points, first that a certain number of fenestrations may partially close resulting in narrowing of the fistula. Since these patients maintain a good hearing improvement and are not revised, there is no way of knowing how many fenestras which are made of what we consider the ideal size subsequently become smaller.

The second point concerns a study of the improvement of the lower frequencies in relation to the size of the fenestra. We have observed that when a fenestra closes it is the lower frequencies that decline first. It is quite possible that the improvement for the lower frequencies will show greater differences according to the size of the fenestra than the speech frequencies which were considered in this study.

Meeting of Monday, April 4, 1955

THE PRESIDENT, DR. NORMAN LESHIN, IN THE CHAIR

Simplified Techniques of Direct Laryngoscopy

ROBERT B. LEWY, M.D.

(Abstract)

This paper represents a progress report on the use of the detachable gear powered laryngoscope holder. It also describes some changes in anesthesia and position techniques and presents a new method for the open field method of per oral laryngoscopy.

The experience of an estimated 1000 cases done by over 100 gear power standard tubular laryngoscope holders has been almost uniformly satisfactory and has made it easier for the operators to expose the anterior commissure, to demonstrate and carefully examine the larynx and to remove polypoid and other growths with crafts-

manlike ease. The position of putting four sheets under the patient's interscapular region and placing the vertex of the head on the table has worked well. It has eliminated both the head holder and the shoulder holder from the operating team, a desirable thing in the average community hospital.

Using 100 mgm of demerol intravenously, given in three minutes by the clock, has been advantageous. The addition of 50 mgm of demerol to disturbed and apprehensive patients, where the dose was inadequate before, has been useful as well.

For an open field method of per oral laryngoscopy the author presented a new tandem system of instruments, much lighter and simpler to use than the standard Lynch apparatus. This is composed of 1) the gear power laryngoscope holder integrated with 2) the standard Jackson slide laryngoscope, in turn integrated with 3) a slightly modified Jennings mouth gag. The laryngoscope holds up the larynx, the mouth gag holds the mouth open, and removing the slide of the laryngoscope gives an open field. Local anesthesia is possible for this work but general anesthesia is recommended.

DISCUSSION

DR. BURTON SOBOROFF: We have used Dr. Lewy's instrument on a number of cases and found it a worthwhile, handy instrument. However, there is a question as to whether or not there is need for such an instrument, and whether this one meets the needs that may be present. We feel that in expert hands such mechanical assistance may not be necessary. However, in doing direct laryngoscopy work this instrument does provide very definite help. It is much like power brakes on the newer cars. Cars used to stop very well, but the addition of power brakes made them much more easily handled.

We have found this instrument worth while from three standpoints: first, the patient; it has been simple to apply. I have not had an opportunity to use other similar instruments, but I imagine they could be applied as well. Second, from the viewpoint of the operator, it permits him to insert the scope and leave it there without strain, which is marked in many instances. It permits him to operate slowly and carefully in work on the vocal cords. Whether it will avoid other operative procedures I am not certain, but I am sure it will permit careful work, a factor which could not be obtained otherwise in many cases and, finally, it has a definite use for teaching purposes. It permits one to insert the laryngoscope without strain and without the possibility of movement if one steps aside to permit visualization of the larynx by someone else.

DR. HARKISHEN SINGH: I would like to ask in how many patients the so-called modified suspension apparatus has been successful; secondly, in how many cases the mandibular block has been successful, if any.

DR. ROBERT B. LEWY (closing): I want to thank the discussors very much indeed. I am glad that the gear power tubular laryngoscope system described has worked so well for Dr. Soboroff. It is my feeling that the ultimate test of any newer system or idea stands or falls more on the experience of the ultimate users than the originators. All work must of necessity be subjected to this discipline for final determination of its value.

Other than in the first part of the paper, this was not intended to be a statistical report but rather a presentation of some ideas and work, part of limited value, and part a dissection and analysis of the mechanics of the open field problem with work performed. In this group I have had about two successful mandibular blocks but, as indicated in the paper, I found the foramen ovale more easily sought after than found and this was not too satisfactory. My recommendation then goes toward general anesthesia rather than a nerve block method. I have had a few reasonable successes for the system of open field work presented. These follow a series of unsatisfactory cases in which I attempted the same thing using a clamp to join the laryngoscope to the mouth peg. I hope that experience in other hands may bear out my own optimism with this system.

Restoration of Hearing in Otosclerosis by Mobilization of the Fixed Stapedial Footplate: An Analysis of Results

SAMUEL ROSEN, M.D.

AND

M. BERGMAN

(Abstract)

Ideally, a surgical procedure for otosclerotic deafness should reestablish the normal function of nature's pathway of sound conduction, i.e., 1) an intact and freely mobile ossicular chain terminating in 2) a freely movable stapedial footplate in 3) nature's oval window. The technique presented here was therefore devised in the belief that hearing would be restored if the fixed stapedial footplate could once again be rendered freely movable.

From 1876 to 1900 various attempts at mobilization of the stapes seem to have failed, and were therefore abandoned in favor of the present day fenestration operation of Lempert. These operations on the stapes were probably discontinued because they were performed through a myringotomy opening which in many cases did not allow sufficient vision for safe and precise manipulation of the stapes.

The present technique is performed under local anesthesia through an ordinary ear speculum in the external auditory canal. After the drum is lifted out of its sulcus, a portion of the bony canal wall is removed in order to have under full view the vital structures to be manipulated. The operation appears deceptively simple, and therefore should be practiced for a long time on the cadaver.

The results in 211 cases operated upon between April, 1952, and August, 1954, are statistically analyzed.

In Class A cases (maximum preoperative loss of 10 db by bone conduction in the speech frequencies) 52 per cent achieved pure tone levels of hearing between normal and 35 db, and 64 per cent reached these levels by speech audiometry. In Class A cases 48 per cent reached the 30 db level by both pure tones and speech audiometry. In this group two patients achieved hearing within normal limits in the speech range.

In Class B cases (maximum preoperative loss of 20 db by bone conduction in the speech frequencies) 39.3 per cent achieved pure tone levels of hearing within normal and 35 db, and 41.4 per cent reached these levels by speech audiometry. In this class 32 per cent reached a pure tone level between normal and 30 db, while 34 per cent reached these levels by speech audiometry. In this group five patients achieved hearing within normal limits in the speech range.

In Class C patients (maximum preoperative loss of 30 db by bone conduction in the speech frequencies) 26.6 per cent achieved pure tone levels of hearing between normal and 35 db, and 28.5 per cent reached these levels by speech audiometry. In this category 16 per cent reached the 30 db level or better by pure tones while 21 per cent reached this level by speech audiometry.

When percentages of improved patients in the categories most suitable for mobilization (A and B) are combined in accordance with the number in each category, 42 per cent reached pure tone levels between normal and 35 db (46 per cent by speech audiometry) while 36 per cent achieved a hearing level between normal and 30 db. If the percentage of improved patients in the Class C category (gener-

ally less suitable) are added to those of A and B, 37 per cent reached levels of 35 db or better by pure tones (40 per cent by speech audiometry) while 30 per cent reached a level of 30 db or better by pure tones (32 per cent by speech).

A total of seven patients obtained a postoperative hearing level within normal limits (less than 10 db loss).

In none of the unsuccessful cases did the hearing fall significantly below the preoperative level.

Patients with early otosclerosis, with a hearing loss of 30 db or less, may be ideal for mobilization since the hearing loss is not great enough for fenestration. Successful mobilization may also contribute to the auditory rehabilitation of a patient with severe otosclerotic deafness when the conductive element is reduced or eliminated.

A case is presented showing that mobilization of the fixed stapedial footplate restored hearing in an ear previously fenestrated without success.

A patient with otosclerotic deafness now has two opportunities for surgical restoration of hearing: 1) mobilization of the fixed stapedial footplate and 2) fenestration.

DISCUSSION

DR. GEORGE E. SHAMBAUGH, JR.: This has been a very interesting presentation. Of one thing I am sure, that this procedure deserves a fair trial before pronouncing judgment for or against it. Dr. Rosen is to be congratulated on his pioneering in this field. As he himself mentioned, he is not the first to attempt mobilization of the stapes. The fact that it had been tried before and abandoned does not necessarily mean that with improved technique it may not give satisfactory results.

Regarding the permanency of improvement, time alone will tell. Logically we would expect the otosclerotic lesion to cause re-ankylosis. However, in following a large number of fenestration operations we have observed that the otosclerotic lesion frequently remains quiescent for a period of years and it is possible that a quiescent lesion might not re-ankylose at least for a considerable period of time.

The indications for the mobilization procedure still need to be more clearly defined. Dr. Rosen apparently includes all cases with stapes fixation as candidates for mobilization. With this I would not agree, at least until further studies have indicated that mobilization can yield as good results in the ideal case as fenestration. At the present time, we are reserving for mobilization the cases which are

not yet sufficiently fixed to warrant fenestration and cases with considerable cochlear degeneration, making them of unquestionable suitability for fenestration.

A very intriguing possibility of the mobilization is the fact that theoretically we might restore normal hearing. We know that fenestration does not restore normal hearing, leaving an average conductive residue of about 25 db for the speech frequencies. Theoretically, with an intact ossicular chain a completely mobilized stapes might restore the hearing to normal without a conductive deficit. I have had the opportunity to observe Dr. Rosen's work and of testing audiometrically several of his successfully operated patients. One of these patients had had a fenestration done elsewhere with an excellent result. Subsequently Dr. Rosen performed his mobilization procedure on the opposite ear and there was no question but that the mobilized ear had the better result. However, while it is theoretically possible for mobilization to restore the hearing to normal, it is disappointing that the majority of Dr. Rosen's operations have shown a residual conductive loss approximating a successful fenestration.

Our own experience with this procedure is limited to 15 operations with only three that have shown a maintained hearing improvement as good as, or better than, might have been obtained by fenestration. Two of these patients with considerable cochlear nerve degeneration received a hearing result from mobilization exceeding the predicted level from fenestration. Against these few encouraging results are several cases with a further drop in hearing in the first test one week after operation and one patient whose stapes was mobilized as part of a fenestration operation resulting in bleeding into the labyrinth probably from luxation of the stapes foot plate. This experience indicates the possibility of possible cochlear damage from an attempt at stapes mobilization. In five patients with unsuccessful mobilizations, fenestration was subsequently carried out with excellent results in all five. However, although an unsuccessful mobilization may later be successfully fenestrated, patients who have once undergone unsuccessful surgery may be reluctant to undergo a second operation.

In closing, I should like to mention an interesting observation for what it may be worth. A patient came to us with a bilateral hearing loss due to otosclerosis with a large amount of cochlear involvement and only slight stapes fixation. Particularly annoying to her was a roaring tinnitus in one ear. Applying the prediction formula fenestration offered no possibility of improvement. Mobilization was suggested and eagerly accepted in the hope that the terrific

tinnitus might be lessened. In exposing the stapedial tendon, the chorda tympani nerve was cut and immediately the patient mentioned that the terrific roaring in her ear had ceased. This was before the stapes had been mobilized. She has been followed for a month since operation with no recurrence of the roaring tinnitus. She also shows no hearing improvement in this ear. I must say that it is difficult to explain this observation since there is no good scientific evidence that the chorda tympani is related to hearing.

Dr. Clair M. Kos: It is a great pleasure to discuss the subject of stapes mobilization as presented by Dr. Rosen and Dr. Shambaugh. It is with some regret that my remarks must be made without having had the good fortune to observe Dr. Rosen's technique or know what he does, except from his publications. In many respects the data presented by Dr. Rosen and Dr. Shambaugh converge to a point of agreement with mine. Dr. Rosen has said nothing with which I can significantly disagree.

My experience has been limited to 65 stapes mobilization operations and from this the following significant facts and impressions have been revealed. Diagnosis must be a hit-or-miss procedure; there are no detailed criteria evident for selection. Prediction cannot be made with a significant degree of confidence. It is apparent that at least three categories of clinical otosclerosis must be considered for application of mobilization. The first one is based on normal bone conduction for pure tone audiometry, with a range of from 20 to 40 db for the air conduction thresholds. Second, complete stapes ankylosis in which the air conduction threshold exceeds the normal bone conduction threshold by 40 decibels or more and, third, stapial ankylosis of any degree with inner ear ankylosis. Regression occurs in the first and second groups, but more frequently in beginning ankylosis; within four to six weeks postoperatively it is most frequent. It has occurred six months postoperatively in this series of patients.

The operation seems to have greater effectiveness in the third group, in which bone conduction thresholds are elevated to such an extent as to preclude the fenestration operation. The technique employed does not compromise subsequent fenestration. After three to six months there is nothing to alter the effectiveness of fenestration. Complications are negligible. Postoperative bleeding occurred in three cases. One patient had serous labyrinthitis; this occurred before antibacterial coverage was used. Penicillin is given intramuscularly the day before and the day of operation. The hearing may be made worse in beginning ankylosis in which the crura are fractured. The usual loss is not more than 10 db.

Of the total of 65 patients, 20 received serviceable hearing or to a level of 30 db or above. If this is broken down, which I shall not take the time to do because the statistics vary little from those of Drs. Rosen and Shambaugh, it is apparent that stapes mobilization is not a reasonable substitute for fenestration, as its application is not sufficiently effective in cases suitable for fenestration. In incomplete ankylosis 80 per cent were improved but in the firmly fixed cases only 20 per cent had improvement. This is impressive, but it is not sufficient to employ it in all cases in which the stapes is completely fixed. It seems to be useful in beginning ankylosis and where bone conduction is elevated to a point that precludes successful fenestration.

DR. JOHN R. LINDSAY: We must congratulate Drs. Rosen, Shambaugh and Kos for giving an excellent presentation of this new procedure. So far no one has shown any microscopic slides to indicate just what was required of this operation, or what may have been accomplished by it. If there is bony fixation of the stapes and you break it, the hearing does not return to normal except in a relatively few cases nor does it improve to the same degree in all. Another point, what is the pathologic picture in far-advanced otosclerosis and what can be expected of attempted mobilization?

I show a section from an early case of otosclerosis to illustrate the condition around the footplate of the stapes. There is a great deal of fibrous thickening around the footplate and an irregular formation of bone. When there is early ankylosis in a case like this, and it is broken loose, a return to normal function could hardly be expected because of the fibrosis about the joint. I think this may be one reason why one may not get a spectacular improvement even in early cases.

If we look at some pathologic slides from advanced cases of stapes fixation we see that it is not just bony ankylosis at the joint, but an extensive change in the whole stapes footplate and crura. It seems obvious that to break such a stapes loose would be most difficult or impossible.

In the next slide from a far advanced case of otosclerosis one can see a similar very advanced and extensive change. There was profound deafness. With such a change in the footplate of the stapes and at the joint, it would be practically impossible to break it loose.

My experience with mobilization is limited to three cases. The first was a case in which I had done a fenestration in one ear, and later the patient's husband accidently mobilized the stapes in the other ear by means of a bobby pin and got a better result than I did. She still has a good result after two years. I have done two cases

since then by the operation of Rosen. One was a failure, the other was successful. I do not wish to discourage the procedure. I notice that Dr. Rosen included cases with profound otosclerosis and deafness as one category of cases for operation. The extent of the pathologic change would probably preclude the possibility of doing a successful mobilization in most of the advanced cases. The nature of the pathologic lesion in the particular case probably has much to do with the chance of success.

DR. M. BERGMAN: I have been closely associated with some of the statistics and am impressed with several aspects of the work. As one interested in rehabilitation, I find one point in particular which I think important. This is concerned with the case where there is a profound loss of hearing due to otosclerosis, where bone conduction is down, where air conduction has reached the level of 70-90 db, and where closing the gap can mean a considerable difference to the patient. We know the limitations of a hearing aid; a patient with a 90 db loss cannot be helped in this manner very much. We have cases that have shown 20 to 30 db improvement following stapes mobilization, not enough to close the gap completely, but this gain made a substantial difference in the patient's ability to use a hearing aid. Rehabilitation with a hearing aid and lip reading would not have been as effective as that.

I want to show one slide illustrating improvement in hearing for 98 of the 211 cases. The question of practical hearing is not involved since this shows the number of patients who achieved gain in hearing following successful mobilization of the stapes. The percentage is a little higher than previously shown for those whose hearing reached the "practical" level. In the Class D group (38 cases) 42 per cent had definite improvement in hearing which may be considered an aid to rehabilitation.

I would like also to point out the close correlation between the results of the speech audiometry and pure tones in the data presented in Dr. Rosen's paper. Except for the "A" category cases, where there was a larger percentage of "successful" cases shown by speech audiometry results, the pure tone and speech test results seem to substantiate each other.

DR. SAMUEL ROSEN (closing): I should like to thank Drs. Shambaugh, Kos, Lindsay and Bergman for their discussion. My experience with the first case operated on three years ago was similar to the first case Dr. Kos did recently. In my patient the hearing is still normal on the side of mobilization. From the beginning I expected that the footplate would re-ankylose but this does not seem

to happen, for in all the patients who reached the 30 db level or better after mobilization only two receded to the preoperative level.

Dr. Shambaugh showed several slides in which the hearing was worse a week after he performed the mobilization operation. This finding is present after all mobilizations for about two or three weeks and is due to blood in the tympanum and reaction of the soft tissues and not to labyrinthitis, of which there are no signs or symptoms. In the 500 cases upon which I have operated I have not had a single case of labyrinthitis. In one case which Dr. Shambaugh fenestrated a week or so after mobilization it is quite possible that if he had delayed the fenestration the hearing might have improved.

The predictability of the degree of fixation of the footplate of the stapes in otosclerosis based on audiological findings will have to be revised. I do not believe it is possible to state with any degree of certainly what the degree of fixation of any particular stapes is going to be. In 500 cases in which I have used my technique for mobilization I have found that the air-bone gap is not necessarily closely related to any predictable finding in the degree of stapes fixation.

Dr. Shambaugh thinks that mobilization should be done only in those patients whose hearing has not gone below the 30 db level and also in those with a mixed type of deafness unsuitable for fenestration, and that the large group of patients suitable for fenestration should not have the mobilization operation. I would take issue with this and include those cases for mobilization who are suitable for fenestration because I was able successfully to improve the hearing of this group to the 30 db level in 48 per cent of the cases. Surely nothing is to be lost by doing the mobilization operation first. The case of which Dr. Shambaugh told us, with intractible tinnitus which stopped immediately after section of the chorda tympani nerve, tends to give us a further clue that the chorda tympani is not only concerned with taste but also with sound and equilibrium. Dr. Kos reported gratifying results in 60 cases in which mobilization of the stapes was done. Dr. Kos, as well as Prof. Y. Meurman whom I visited in Helsinki nine months ago, was able to work out for himself my technique for mobilization of the stapes.

In discussing some aspects of this work with Dr. Lindsay this evening, it seems that we have both had the experience that even though the footplate of the stapes seems in some cases to be moving, yet the mobility does not seem to be free enough. Dr. Lindsay suggests that at times a fibrosis around the footplate of the stapes prevents the hearing from attaining the higher levels, because the footplate is not rendered mobile enough.

VILRAY PAPIN BLAIR

1871-1955

Dr. Vilray P. Blair, one of the world's foremost plastic surgeons and a pioneer in the speciality, died at the age of 84 on November 25, 1955, of the infirmities of age.

His ties with otolaryngology, dating from his early associations with Greenfield Sluder, were many and intimate. Aside from his membership in numerous surgical societies, he was a diplomate of the American Board of Otolaryngology and a Corresponding Fellow of the American Laryngological Association.

He was an unforgettable character and a dramatic teacher. Precedent weighed but lightly on his surgical thinking and procedures. He knew his anatomy well enough to be able to disregard it when he chose, and startling as some of his methods occasionally were, they worked.

The following very illuminating sketch of his career is from the St. Louis Post-Dispatch of November 25, 1955, and is reprinted with that journal's kind permission:

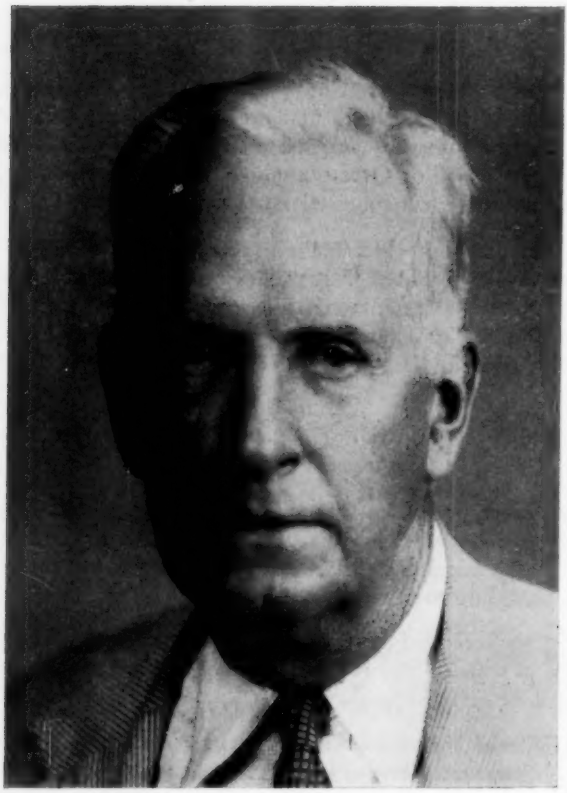
"Dr. Blair, professor emeritus of clinical surgery at Washington University School of Medicine, was one of the pioneers of plastic surgery in the United States. His outstanding achievements in this field brought him many honors.

"He was credited with developing ramisection of the jaw, an operation in which nerve roots are divided to correct deformity. He also had done original work on cleft lip and cleft palate.

"In World War I he was in charge of plastic and oral surgery for the United States Army, and served as chief consultant in maxillofacial surgery to the American Expeditionary Force.

"Dr. Blair was a native of St. Louis and a descendant of the Papins, one of the original French families here. His parents were Edmund Harrison and Minnie Papin Blair. His grandfather, Timothy P. Papin; two of his maternal uncles and his father-in-law, the late J. B. Johnson, all were physicians.

"Had he been left to follow his first inclination, he might have become an electrical engineer, but his family exerted great pressure in favor of a medical career. After attending Christian Brothers



VILRAY PAPIN BLAIR

College he obtained his M.D. degree from Washington University in 1893 and interned at the old St. Louis Mullanphy Hospital.

"In 1894 he began a teaching career at Washington University which led from instructor in practical anatomy through half a dozen other positions to professor of clinical surgery in the school of medicine and of oral surgery in the school of dentistry.

"When the Boer War broke out in 1899, Dr. Blair obtained a leave of absence from the university to serve as a surgeon in the British merchant marine and as a troop surgeon in Africa.

"As a young teacher he had a student who, because of a malformed jaw, seemed destined to go through life severely handicapped. Dr. Blair offered to try corrective surgery. A difficult operation in which sections of jawbone were removed proved successful.

"Soon all kinds of bizarre surgical problems were being sent to the surgeon. For a boy who had his jaw shot off in a shotgun blast, he removed a section of shoulder blade and formed a new jaw. A woman disfigured by burns had her eyelids rebuilt with portions of her own skin and hair. The Annals of Surgery described the operations by which a girl who lost the first joint of a finger had a section of one of her toes removed and transplanted to the injured finger.

"Members of the American Association of Oral and Plastic Surgeons met in St. Louis in 1934 to honor Dr. Blair and observe his work. The Mississippi Valley Medical Society awarded him its distinguished service medal in 1938. The St. Louis Medical Society in 1947 presented him with a gold medal and a certificate of merit for scientific accomplishment.

"He was cited as a 'sculptor in living flesh' when Washington University conferred on him the honorary degree of Doctor of Science in 1949.

"Dr. Blair was the author of textbooks and numerous papers on surgery and diseases of the mouth and jaws. He gave up his teaching in 1942, and retired from active practice in 1946, when he reached the age of 75.

"The surgeon was a decided individualist. Because he got tired of looking at bare walls in the operating room, he commissioned Gisella Loeffler, a St. Louis artist, to decorate the walls with colorful and fanciful paintings.

"From the days of his youth, when he spent a summer working as a telephone linesman out West, Dr. Blair was fond of travel. He

acquired a bus, equipped it with a kitchen and bunks, and made a number of vacation trips in the vehicle.

"Dr. Blair remodeled an 1850 farm house on Old Jamestown road near Florissant into a weekend lodge. By stages he expanded this into his "River Farm" home, with a terrace overlooking the Missouri river and a road winding down the steep bluff to a dock on a quarried inlet."

He married Miss Kathryn Lyman Johnson in 1907. She died in 1950. He is survived by two sons, John Blair and Dr. Vilray P. Blair Jr.; two daughters, Mrs. George A. Lane and Mrs. James O'Leary, and two sisters, Mrs. Richard Boyle and Miss Marguerite Blair.

JOHN MacKENZIE BROWN

1878-1955

The passing of John MacKenzie Brown, after almost fifty years of distinguished service, is a distinct loss to otolaryngology.

He was born in London, Ontario, Canada in 1878. At the age of twenty-one he was graduated from the medical school of the University of Western Ontario.

His first venture in medicine occurred in a small farming community in Nebraska where he engaged in general practice. Among the most common and distressing diseases of that time were the unrecognized complications of infections of the ears and sinuses which were designated as brain fever. It was brain fever which challenged this country doctor and influenced him to prepare for the practice of otolaryngology.

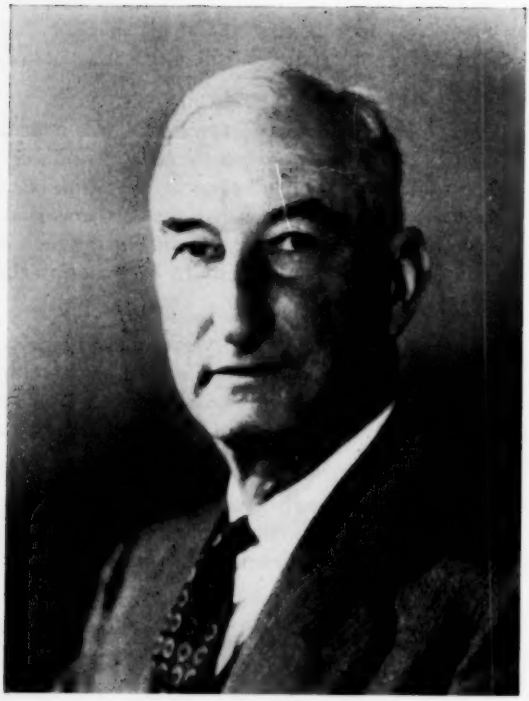
After studying in Michigan, Pennsylvania and Harvard he completed his preparation in Edinburgh and visited the teaching centers of Europe. In 1909 he was licensed in California and began a career in Los Angeles which was to end in national recognition of his services and contributions.

His ability and quiet unaffected manner won immediate approval. He was welcomed on the staff and as consultant in the leading hospitals where his recommendations were generally accepted as final.

John MacKenzie Brown's main interests were the Children's Hospital, the Medical School of the University of Southern California and the Los Angeles County General Hospital. He served them all as chief of staff, professor and head of the department. All were to become famous under his leadership.

Among the most notable of his contributions to our literature are his methods in diagnosis and treatment of infections of the frontal sinuses, the mastoids and their intracranial complications. These have become known wherever otolaryngology is practiced.

Many local and national honors were conferred on Dr. Brown. He served as president of the American Laryngological, Rhinological and Otological Society in 1941 and president of the American Academy of Ophthalmology and Otolaryngology in 1950. In 1951 he was guest of honor of the Pacific Coast Oto-Ophthalmological Society.



JOHN MacKENZIE BROWN

For many years he held a clinic on Wednesday afternoons at the Los Angeles County General Hospital for all who were interested regardless of staff appointments. Here the unusual and puzzling problems in diagnosis and procedure were presented. After a recital of the history and findings each doctor was asked to examine the patient. Then a general discussion was held and the final recommendations made. This clinic was an inspiration. It was attended by local doctors and many from distant cities.

John MacKenzie Brown retained his enthusiasm for his work and his friendships to the very last. For many years he was known affectionately as the Chief or as J. M. His loss has thinned the ranks of the honor guard which bridged the gap between the old and new techniques of otolaryngology. He will be greatly missed.

He is survived by his widow, Marion, two daughters, two sons and six grandchildren.

D. H.

Abstracts of Current Articles

EAR

Experimental Study of the Efficiency of Two Group Hearing Tests.

Johnson, Kenneth O. and Hayes, A. Newby: A. M. A. *Arch Otolaryng.* 60:702-710 (Dec.) 1954.

The heart of a hearing conservation program is a hearing testing survey but the best method of conducting this survey is not agreed upon by all otologists and educators. The two chief types of testing used are the group test or the individual "sweep-frequency" test with pure-tone audiometer. The two principal forms of group testing in use are the Western Electric group phonograph speech audiometer (fading-word test) and the Massachusetts hearing test, a pure-tone "sweep" test applied on a group basis. The former is in more common use, having been known for 30 years, while the latter was developed after World War II. The advantage in group testing lies in the larger number of subjects who can be tested in a relatively short time and the advantage of the individual test in the more accurate evaluation of hearing.

Reasonable efficiency in discovering cases of hearing impairment is an essential criterion of a good method of testing. The Western Electric method has been subject to considerable criticism on this score. Those advocating group pure-tone testing feel it is more efficient in detecting hearing loss in general and high-frequency loss in particular and is no more difficult to administer than the Western Electric test. Otologists and educators are faced with two unanswered questions: (1) Is group pure-tone testing more efficient than the phonograph test? (2) If so, is it sufficiently superior to justify replacement of existing phonographic audiometric equipment?

To answer these questions the authors set up a research project to compare the Western Electric and Massachusetts hearing tests. Both group tests were administered to 1496 children from kindergarten through sixth grade in four elementary schools in California. (In reporting their findings, they segregated those in the kindergarten through second grade and those in the third through the sixth grade.) In addition to the group tests, each child was given an individual pure-tone sweep test at the 15 db level and all who failed this were given an individual pure-tone threshold test. Any child

exhibiting a hearing loss in either ear of 20 db at two frequencies or 30 db at one frequency was considered to have a "medically significant" hearing loss. The efficiency of the two group tests was determined on the basis of the accuracy with which it singled out the significant hearing losses and the accuracy with which it identified the subjects with normal hearing. The conditions under which the tests were done are described in detail.

The authors found the Western Electric 4CA group phonograph audiameter an inefficient screening device. On the basis of individual tests 5.81 per cent of the older subjects and 7.02 per cent of the younger passed the group test when they should have failed. In the older group on Western Electric testing 79 per cent of the hard of hearing children went undiscovered and a similar percentage of the younger children were likewise not picked out by this test. In detecting normal hearing, the Western-Electric test was inefficient in the higher grades, wrongly failing 5.59 per cent of the ears tested and referring 51 children needlessly for individual testing. With the younger children, the Western Electric test satisfactorily identified normal hearing. The Massachusetts test proved much more efficient —only 18 per cent of the older children who should have failed the hearing test were wrongly passed; in the lower grades it wrongly passed 31 per cent; thus the Massachusetts test was successful in discovering four out of five hard of hearing children in the higher grades and seven out of ten in the lower grades and it was satisfactory in both age groups in correctly classifying normal ears. The Massachusetts test missed one out of five in the older group who, on individual test, showed significant loss.

Johnson and Hayes feel that the Massachusetts test is acceptable in its efficiency in the third through the sixth grade group and, considering the difficulties in testing the younger group, perhaps in this group also. They think, however, that so much success in testing the younger age group is dependent on the audiometrist's skill in observing individual behavior, that the preferred method is individual testing.

In searching for a reason for the failure of the Western Electric test to make a better showing, the authors state they feel it lies in this test's utilization of extremely simple speech stimuli. Many children who failed the individual tests did so on losses in frequencies outside of the speech range. Therefore, to correlate highly with individual tests, group tests must be of pure-tone, rather than speech, type.

In casting about for methods of improving the Massachusetts test, they suggested that perhaps the failure criterion of the test might

have been too lax and probably more impaired hearing could be discovered, without failing an unreasonable number of normal ears, if the acceptable levels were reduced slightly.

HILDING.

Pure Tone Audiometry for Pre-school Children.

Barr, B.: Acta Oto-laryng., Suppl. 110.

This report is based upon studies of 300 children ranging from 1 to 6 years of age, using psychogalvanic skin-resistance audiometry, and play-audiometry after the method of Dix and Hallpike, but using educational toys in "series games." Comparison between these two techniques showed only negligible differences and follow-up examinations one to two years later revealed unchanged audiograms. With children two and a half to three years of age play-audiometry is considered preferable.

HILL.

Cerebral Abscess Due to Proteus Mirabilis and Pneumococcus.

Rodriguez, T. B., and Leguizamo, J. M. A. An. Oto-Rino-Laringol. del Uruguay, 2:24, 44-49, 1954.

The case is cited of a woman 52 years of age who complained of loss of hearing in the right ear followed by sudden acute pain. On the following day intense headache, pain over the mastoid, meningeal symptoms and fever (39.5°C) were present. Otoscopy revealed redness and bulging of the tympanic membrane; Paracentesis was performed. The cerebrospinal fluid pressure was elevated, contained 520 cells and albumin. The patient became comatose. Treatment consisted of streptomycin, gantrisin and hypertonic glucose solution.

The cerebrospinal fluid obtained by a second puncture was less turbid, contained only 60 cells, less albumin and no bacteria. The temperature became normal. However, four days later the patient became restless, showed mental clouding, intense headache, and vomiting. The albumin and cells in the cerebrospinal fluid increased. Exploration of the mastoid antrum revealed a small zone of diseased bone. The material removed for biopsy was fetid and pasty, resembling cholesteatoma. The healthy bone was curetted. The postoperative condition was good. The patient was free from pain, but the temperature remained between 37.5° and 38° C. The condition was otherwise normal for some time, but the headache, insomnia,

restlessness and mental confusion recurred. Left facial paralysis developed and the temperature rose to 39° C. The diagnosis was cerebral abscess, probably located in the right temporosphenoidal lobe, as indicated by a positive Babinski sign on the right side, and adominal hypoesthesia.

Immediate operation was performed through the petromastoid route. The tegmen of the middle ear was removed. Puncture of the meninges elicited pus. Streptomycin was injected and a rubber drainage tube was introduced. The wound was kept open with tampons. The drainage and streptomycin were continued. A fluid containing serum and blood was aspirated through the tube. The cavity was flushed out with a solution of streptomycin. In ten days the temperature returned to normal. The drainage tube was removed, and the wound healed. Recovery was complete.

Bacteriologic examination of the exudate revealed *Pneumococcus* and *Proteus mirabilis*. Some time later phlebitis of the left leg developed in an old varicosity. A later encephalogram revealed signs of the temporal lesion.

In 80 per cent of cases, cerebral abscess is due to otitis, especially of the temporosphenoidal lobe. The infection reaches the brain through a perforation of the roof of the tympanum, or by way of a fissure in the petromastoid bone, or is carried by the cerebral blood vessels resulting in a metastatic abscess. As a rule the infection is by direct contiguity. Sometimes a pachymeningitis results in adhesions between the meninges and the cerebral cortex, followed by encephalitis and abscess. The infection may also be carried through the lymphatic channels. The most frequent causes are streptococcus, pneumococcus, staphylococcus, Friendlander's bacillus, Bacillus coli, meningococcus, Koch's bacillus, and Entamoeba histolytica. Occasionally the abscess is sterile. The development of the lesion is slow. The cerebral abscess may be acute or chronic depending upon the virulence of the causative organism. In the case cited, the patient was fully recovered ten months after the operation.

HIGBEE.

Secondary Skin Grafting in Fenestration and Mastoid Cavities.

Guilford, F. R., and Wright, W. K. Laryngoscope 64:7, 626-630 (July) 1954.

The authors suggest the use of secondary skin grafting for mastoid and fenestration cavities as a simple office procedure. It is their contension that their technique produces a healthier infection-resistant skin lining as well as a reduction in healing time.

The technique consists of obtaining a split thickness graft from the under surface of the upper arm using 1 per cent procaine anesthesia. This is mounted on "surgical fabric" using aureomycin ointment as an adhesive.

On the 10th to the 18th postoperative day when the granulations line the cavity it is considered ready for grafting. The grafts are applied in six or eight strips, first covering the tegmen, then the posterior wall of the cavity, the anterior wall of the external auditory canal, the facial ridge and the soft tissues of the lateral wall of the cavity and the bare areas of the meatus. Careful attention is directed to intimate contact of the graft with the granular areas of the bowl. The graft then adheres so tightly that packing of the cavity for fixation of the graft is not necessary. The fabric is removed from the cavity 7 to 14 days after grafting by sliding or lifting the fabric off the graft with a fine ear hook.

The healing time in 60 fenestrations, 14 modified radical mastoidectomies and 6 radical mastoidectomies are listed. The average healing time for 100 fenestration cavities not grafted was 4.4 months while that for the 60 cases which received secondary skin grafts averaged 1.7 months.

SENTURIA.

Acoustic Trauma.

Saltzman, Maurice, and Ersner, Matthew S.: A.M.A. Arch. of Otolaryngol. 62: 235-241 (Sept.) 1955.

The authors divide acoustic trauma into three classes: 1) The insidious and slowly progressive type, which results from exposure to excessive noise over a period of years. 2) Inner ear damage from sudden noise, such as that of a detonation of a cannon or a rifle. This type presents a wedge-like high frequency loss with tinnitus, which is measurable, and diplacusis. There is also a marked lowering of the threshold of discomfort. 3) Progressive degeneration which follows acoustic damage; even though there is no further exposure to noise, degeneration continues.

The authors describe two cases in which there was a high-tone wedge-like loss and in which there was a marked lowering of the threshold of discomfort. Both were greatly relieved by ear protectors and one was relieved by low tone sounds. The authors suggest that masking tones of low pitch may be of physiotherapeutic value in some cases of acoustic trauma.

HILDING.

NOSE

Pathology and Treatment of Oro-Antral Fistulae.

Bennett, R. J. and Moore, J. R.: Jour. Otol. and Laringol. London 68:535 (Aug.) 1954.

Twenty-nine cases of oro-antral fistulae of dental origin form the basis of the paper. These are classified as: Type 1, recent fistula, no sinusitis; Type 2, recent fistula, acute sinusitis; Type 3, fistula, subacute sinusitis; Type 4, fistula, chronic sinusitis.

Treatment of the sinusitis is stressed, as is the tendency of fistulae to close spontaneously.

Methods of closure include sliding palate flaps or buccal flaps, if a Caldwell-Luc is necessary to control infection.

Nine illustrative cases are reported.

SOOY.

Sinusitis, Granuloma of the Nose and Periarteritis Nodosa.

McCallum, A. G.: Jour. Laryngol. and Otol. 68:560 (Aug.) 1954.

Periarteritis nodosa following sinus suppuration is rare but previous cases are noted, three having had Caldwell-Luc operations.

An illustrative case is reported involving a 31 year old male who presented himself with a left maxillary sinusitis and left septal granuloma.

There was no history of prior sulphonamide therapy.

Penicillin, aureomycin, streptomycin and cortisone did not control the local disease.

Systemic signs including malaise, anorexia, muscle and joint pains, pulmonary infiltration and renal failure led to death in nine weeks.

Autopsy findings included: 1) A simple nasal granuloma, 2) purulent left maxillary sinusitis, 3) pulmonary periarteritis, 4) necrotic renal glomeruli and perivascular infiltration, 5) completely necrotic and infarcted spleen.

The disease is believed to be an antibody-antigen reaction "hypersensitivity angiitis," in many instances following sulphonamid sensitivity.

SOOY.

The Osteoplastic Operation for Chronic Infection of the Frontal Sinus.

MacBeth, Ronald: Oxford Jour. Laryng. and Otol. 68:465 (Oct.) 1954.

The author describes his experiences with the osteoplastic operation of Gibson and Walker.

The frontal sinus is entered via a hairline incision through the pericranium which is elevated to the previously mapped extremities of the frontal sinus. The sinus is then entered by first outlining the margins with a dental perforating burr and then connecting the perforations with the same instrument. The outlined anterior sinus plate is fractured anteriorly and allowed to remain attached to the scalp flap for later replacement.

All sinus mucosa is carefully removed, the sinus septum resected and appropriate drainage provided into the nose.

The scalp with the bony plate attached is replaced.

The advantages listed include: excellent exposure, restoration of forehead contour, no interference with the supraorbital nerves or orbital structures and obliteration of the sinus principally by bone.

An ingenious method of accurate presurgical mapping of the frontal sinuses is illustrated.

The paper covers sixteen cases, five of which are reported briefly.

Sooy.

LARYNX

Cicatricial Stenosis and Atresia of the Larynx.

Otte, G. J.: Rev. Otorinolaringol. 13:2:81-86, 1953.

In some cases in which intubation and tracheotomy have been done in the treatment of laryngotracheal bronchitis, it has been impossible to remove the cannula, due to laryngeal atresia or cicatricial stenosis. Occasionally a psychic block, or phobia, may prevent decannulation. As a rule, however, the disturbances following high tracheotomy are due to actual lesions such as ankylosis, interference with laryngeal function, ulcerations and consequent cicatricial stenosis. Infections or specific laryngitis, arthritis of the crico-arytenoid articulation, perichondritis, or necrosis of the cartilage may also play a role.

The author considers intubation contraindicated in subglottic laryngitis. It is the most frequent cause of acute respiratory obstruction in children, due to trauma of the larynx. During attacks of

coughing the tube may cause lesions which result in cicatricial stenosis. and eventually in total occlusion. The stenosis of adhesions between the walls of the larynx, or the cartilage, in which case suppuration is followed by arthritis and sequestra.

The usual treatment of the stenosis consits in cauterization or curettage, cordectomy, low tracheotomy, gradual dilation of the passage with metal dilators or rubber tubes, increasing progressively in size. The treatment is frequently prolonged and painful, especially in the case of children. If complete atresia is present, a very fine rubber tube may be gradually introduced through a tracheotomy opening, and the passage progressively dilated. In place of the tubes, tampons of vaseline gauze and Thiersch grafts have been used.

To avoid the difficulties and pain entailed by these methods, the author uses the following technique. Under general anesthesia given through a tracheotomy opening, a laryngeal fissure is performed. After the obstructive cicatricial adhesions are resected, an acrylic tube is inserted into the larynx. The lower end of the acrylic tube is sutured to the cannula. The skin wound is sutured. Beginning on the day of the operation, 100 mg of cortisone are given daily for two or three days, then 75 mg and later 50 mg for one month. At this time the acrylic tube is removed, and the tracheotomy opening is closed. If respiration is still obstructed, due to local edema, the tube, or a larger one, is reinserted and cortisone is again given. Good results have been obtained by this procedure.

HIGBEE.

Ligation of the Internal Carotid.

Samengo, L. A. and De Sabastian Leon, G.: Acta Otorinolaringol. Ibero-Amer. 5:4:239-259, 1954.

In cases of advanced malignant tumors of the larynx with extensive involvement of the lymph glands and adhesions to underlying tissues, x-irradiation is usually ineffective. The authors suggest a radical procedure which presents definite advantages, even though the inherent hazards must be considered. Treatment depends upon the size and position of the tumor. In the case of small incipient lesions which do not impede the mobility of the larynx to any extent, with or without involvement of the lymph glands, roentgenotherapy is indicated. If the tumor does not respond to x-rays, non-mutilating surgery is required, such as, laryngofissure or partial laryngectomy. Advanced forms of epithelioma, which are hard and adherent to underlying fascia and which invade the thyroid, tongue, muscle and large blood vessels of the region, respond only to surgery. Irradiation

is injurious because of the high dosage required for a large area; the rays may result in necrosis of the ulcerous lesions which are usually present. Extensive resection of cervical, vascular and nerve tissue, and of the lymph glands is required. Ligation of the internal carotid and removal of the tumor is the only method of saving the life of the patient. In spite of the risks, the alternative is certain death. The elastic muscular tissue of the internal carotid is resistant to neoplastic invasion. The artery can be carefully dissected away from the invaded adventitia and surrounding lymphatics. If the neoplasm has invaded the muscular coat, radical resection is necessary, following ligation of the artery. In order to combat recurrence or metastases, radium needles should be left in place and the wound left open. Ligation of the artery affords an adequate operative field for the implantation of the radium.

The dangers which must be considered include that of punctures or lesions due to instrumentation, followed by violent gushing of blood under pressure. Strong manual compression or a hemostat should be applied immediately, the artery ligated, and the puncture sutured. Delayed complications include contralateral hemiplegia, either temporary or permanent, usually affecting the arm and face. These disturbances may be attributable to cerebral ischemia, sympathetic, injury of the carotid sinus and its nerve center regulating respiration, blood pressure and pulse, to intracerebral hemorrhage, to thrombosis or to embolus. However, surgical complications of this nature occur in only 14 to 30 per cent of cases, whereas the malignancy is fatal if untreated.

The irritation of the sympathetic system can be reduced by novocaine injected into the paracarotid spaces.

The prognosis depends upon the absence of metastases, the age of the patient and the absence of arteriosclerotic lesions. In 24 cases reported by the authors complications were: temporary hemiplegia, six; permanent hemiplegia, one; monoplegia, one; death due to syncope caused by the bulbocarotid reflex, one.

The extirpation of the tumor is usually carried out under general anesthesia, although novocaine infiltration is sometimes preferred.

In all 24 cases treated, it was necessary to resect the internal jugular, because of its invasion by the malignant process. If both jugulars are involved, they should be removed in two separate stages with a safe interval between operations. If the lymph glands on both sides are affected, the less severely involved side should be operated upon first.

HIGBEE.

Nodule of the Vocal Cord.

Tarneaud, J. Acta Oto-Rino-Laringol. Ibero-Amer. 5:336-348, 1954.

A nodule on one or both vocal cords may be due to catarrhal inflammation or to recurrent irritation but is usually caused by trauma from forced phonation and vocal strain. The nodules are especially apt to occur in asthenic conditions, anemia, during convalescence, etc. The repeated vocal trauma results in edema and keratinization. The most frequent site is the junction of the middle and anterior thirds of the vocal cord. The node forms only if the extrinsic and intrinsic laryngeal muscles are hypotonic. If paresis of the adductor muscles develops, a triangular fissure appears in the glottis with its base at the interarytenoid commissure. Paresis of the tensor muscles results in hypotonus and fatigue which produces a gap between the cords. If both adductor and tensor muscles are paretic, the cords do not close enough to cause pressure or friction.

The nodule may be gray or reddish. It presses upon the opposing cord, forming a depression and may even result in a second nodule at the point of friction known as a "kissing nodule." Mucus is apt to accumulate and induce cough or clearing of the throat. This condition is seen most frequently in teachers, lawyers, auctioneers, or others whose occupation requires excessive use of the speaking voice. It is recognized by alteration in the rate of vibration of the cords, such as "flag vibration" of the free edges. Symptoms include hoarseness, especially of deep tones, loss of resonance, and frequent clearing of the throat, indicating vocal fatigue. High, pianissimo singing tones cannot be maintained without breaking, and are sometimes impossible. Deep, loud tones are emitted only with effort.

Treatment depends upon the form and duration of the nodule, trophic changes in the cords, and the psychologic reaction of the patient. Fibrous nodules should be removed surgically. Recent edematous nodules may disappear spontaneously after rest for four or five days. If two opposing nodules are present, one should be removed surgically. Nodes which are not sharply defined are not operable, and must be corrected by exercises and vocal re-education. In the case of singers the nodule is almost always due to faulty use of the voice and will recur unless proper singing technique is used.

Immediately after operation the patient should test his voice, and should then observe complete vocal rest for five or six days. Healing inhalations are beneficial. The speaking voice is restored rapidly, but the singing voice should not be used until stroboscopic examination shows complete recovery of the cord vibrations. Perma-

nent recovery is possible only if the faulty use of the voice is corrected by orthophonic exercises, phonetic reeducation and proper singing lessons.

HIGBEE.

PHARYNX

Lymphomas of the Nasopharynx and Pharynx.

Friedberg, Stanton A. and Hass, George M.: A. M. A. Arch. Otolaryng. 60:677-694 (Dec.) 1954.

A tumor of the nasopharynx or pharynx may be the initial manifestation of certain lymphoid disorders. At this time there is no accurate way of predicting the subsequent behavior of varying types of lymphoid tumors of this area. Pathologists are concerned with the etiology and pathogenesis of various lymphoid diseases; these conditions are characterized by a lack of any sharp features of distinction one from another. The authors concur in the propriety of a general classification of lymphoid disorders but, in the series they report, have tried to identify and classify the tumors and relate the clinical and pathologic aspects.

The authors have analyzed the clinical and pathologic data on ten patients who presented themselves with symptoms referable to the nasopharynx or pharynx and who were found to have a primary lymphomatous neoplasm of the pharynx without simultaneous evidence of systemic involvement or of disease elsewhere in the body. In an addendum to the paper, they report two additional cases seen subsequent to the original publication. These ten case reports present the salient features of the patients' histories, physical examinations, laboratory data, therapy and course subsequent to the original examination. The histologic picture is detailed in each instance. The pertinent illustrative features exhibited by each patient are pointed out at the conclusion of each case report.

From this study the authors have concluded that in giant follicle lymphoma, response to radiation therapy is excellent and the survival rate fairly high, especially when only a localized form exists. Future behavior, rather than histologic examination, will probably determine the ultimate classification of the lymphoma. Some authors have pointed out that nothing in the histologic character of an individual lesion will permit a reliable forecast as to the distribution of the process in other parts of the body. The clinical course of two of their patients with malignant lymphoma— lymphoblastic and lymphocytic types—seems to support some writers' contention that lymphosar-

coma may be of monocentric or multicentric origin. An apparent cure is possible but the lymphomas are much more likely to terminate fatally. Therapy, tho effective in controlling the disease, may be responsible for the fatal outcome. The course of lymphosarcoma is influenced by individual inherent qualities for growth and dissemination, which some workers feel are the most important and probably the least definable factors.

One of the authors' cases illustrated that, as in most malignant lymphomas, the response of the primary lesion to irradiation was immediate and complete and was followed by the appearance of a new area of involvement. Another case was characteristic of the lack of sharp division of classification among malignant lymphomas, with one patient showing microscopic features common to reticulum cell sarcoma, lymphoblastic sarcoma and Hodgkin's disease, leading to considerable variation in opinion among the pathologists reviewing the sections. This tended to support the belief that these tumors are essentially of common origin. There are no clinical features which alone permit differentiation of the various forms of malignant lymphoma.

An interesting feature of two cases was the extensive fibrous replacement of lymphoid tissues and often associated hyaline degenerative changes found at postmortem examination, probably resulting from therapy of what the authors feel must surely be regarded as a systemic disease affecting the lymphoid structure of the entire body. They state that similar changes are known to occur also in spontaneous regression and fibrosis of neoplastic tissue in lymphomatous disease.

The pharyngeal tumor in three cases seemed to be only an incidental, through recognizable, manifestation of an already disseminated lymphoid disorder. The authors feel it is not certain whether this dissemination is the result of direct extension, metastasis or independent foci of multicentric origin.

The series of twelve cases reported by Friedberg and Haas included one patient with giant follicle lymphoma, two with malignant lymphomas of the lymphoblastic type, two with malignant lymphomas of the lymphocytic type, one with malignant lymphoma of the Hodgkin's type and four with malignant lymphoma of the reticulum type, as well as one reticulum cell sarcoma and a lymphoblastic type of lymphoma mentioned in the addendum.

The differential diagnosis is discussed with the conclusion that one must rely almost entirely on biopsy of the local tumor mass and if possible a cervical lymph node.

HILDING.

BRONCHI

Endobronchial Treatment of Tuberculosis.

Castella Escabros, A. Acta Oto-Rino-Laringol. Ibero-Amer. 5:349-369, 1954.

Bronchoscopic treatment is indicated in cases of bronchial perforation occurring early in tuberculosis, bronchial ulcers, stenosis, and persistent cavitation. Recurrences of tuberculosis are relatively frequent after the age of sixty years.

Treatment consists of antibiotics and aspiration to remove caseous material, calcareous sequestra and local application of silver nitrate and adrenalin. In adults the most frequent and severe tuberculous lesions of the bronchi are deep ulceration and stenosis due to postoperative scar tissue, especially if streptomycin has been used to induce rapid healing. In 64 of 122 cases observed by Lemoine, x-rays showed bronchial ulcer, active tuberculosis and cavitation.

The early stage of the stenosis is usually inflammatory and obstructive. The surface bleeds readily, and exudes a purulent secretion. Small ulcerative patches should be cauterized with silver nitrate and adrenalin applied. If neglected the condition may result in bronchiectasis or in cicatricial stenosis. The surface of the bronchus is congested, occasionally hard, pale or pearly with fibrous bands which impedes the passage of the bronchoscope. The application of vasoconstrictor medication may relieve the congestion. In extreme cases removal of the tuberculous lung is indicated, if residual cavities remain, after pneumothorax, or if edema and fungi are present. Whether the primary infection is pulmonary or bronchial, the primary and secondary lesions aggravate each other forming a vicious circle. Therefore, both general and local treatment are necessary. In any case, bronchoscopy is essential in establishing the diagnosis and in facilitating endoscopic intervention. To locate the pulmonary cavities, frontal and profile roentgenograms are useful. The bronchoscopy should be carried out under local anesthesia to prevent uncontrolled coughing.

Frequently the inflated pulmonary cavities cannot be deflated because of the bronchial stenosis which prevents escape of air and of sequestra. Therefore, the obstruction must be cleared up first by aspiration. If the infiltration is caused by fungi 20 per cent silver nitrate is used.

Artificial pneumothorax is the most effective method of treating pulmonary cavities if the prophylactic effect of bronchoscopic treat-

ment is not sufficient. If this is not effective, the only recourse is lobectomy. Antibiotics should be given in all cases. Regardless of the primary site of the infection, bronchoscopic therapy should be tried before more radical intervention is undertaken.

HIGBEE.

TRACHEA

Cancer of the Trachea.

deCardenas, J.: Rev. Cubana Oto-Rino-Laringol. 4:1:28-33, 1955.

In most cases tracheal cancer runs a rapidly fatal course. It generally occurs between the ages of 50 and 70 years, and is more frequent in men than in women. The most common type is epidermoid carcinoma, although cylindroma and adenocarcinoma are occasionally observed. The prognosis is more favorable in sarcoma which can be extirpated endoscopically by electrocoagulation.

The initial symptoms are cough and hemoptysis. As the tumor grows, dyspnea, dysphagia and vocal cord paralysis develop which may require tracheotomy and the insertion of a cannula to permit respiration.

Tracheoscopy and biopsy will establish the diagnosis. Roentgenography of the affected area is necessary to define the extent of the lesion. Treatment consists in radiation or surgery, preferably endoscopic electrocoagulation followed by deep roentgenotherapy or by the insertion of radon seeds. Following extirpation of the affected portions of the trachea, polyethylene tubes and tantalum plates are sometimes inserted.

In the author's case, roentgenotherapy alone gave excellent results. The patient was 53 years old. For about a year he had expectorated blood and mucus, especially on coughing. Laryngoscopy revealed an ulcerous lesion 3 to 4 cm below the cricoid, involving the anterior wall and right side and obstructing the tracheal lumen. Biopsy established the diagnosis of epidermoid epithelioma.

Roentgenotherapy was employed in daily doses of 300 r; a total of 6,000 r was given over a period of 26 days (25 r per minute). Codeine was administered to control cough, and also Vitamin B complex and folic acid were prescribed.

A subsequent exudative radiodermatitis healed within three weeks and the patient's condition was excellent. Periodic examination over five years following treatment showed the lesion to be completely healed, without recurrence.

HIGBEE.

Work Plan of the Study Center for Laryngeal Cancer.

Alonso, J. M. An. Oto-Rino-Laringol. del Uruguay, 24:1:9-13, 1954.

To supplement the work of the Latin American Committee for the Study of Laryngeal Cancer, the Center in the Medical School of Montevideo has begun a program of social service and has laid out a plan for further expansion. The program will include moral and financial aid following surgery and irradiation. Records are kept of the economic status of the patients before and after treatment, of their working and living conditions, as well as their medical history.

Preoperative treatment includes dietetic and medical supervision, the administration of vitamins and of fresh fruits, to ensure a favorable reaction to the operation.

Following operation, care is taken to prevent complications. A polyclinic and a dental clinic are available for prophylactic and preventive care. Classes are provided for vocal re-education. A social worker visits the patient to observe the economic and family conditions and to give any assistance required to maintain his general health.

The social work includes raising the morale of the patient prior to operation and providing financial support for his wife and children during the period of hospitalization and convalescence and until he is able to resume his occupation. If he is partially incapacitated, the employer is induced to give him more suitable employment. If he is unable to work, adequate assistance is given, either financial or in the form of clothing or food. Through the co-operation of business firms, Christmas gifts for children are provided.

A Mutual Benefit Society has been formed by the patients themselves who pay dues according to their ability for the aid of less fortunate individuals.

In some cases pensions are paid. Legal advice is available, for assistance in obtaining citizenship and birth certificates if the patient moves to another location.

Recreation is afforded, in the form of rooms for billiards, card games, chess, etc. These are of help in the psychologic recuperation of the patient following operation. Motion pictures, mainly documentary and instructive films, for the benefit of the patients and their families are shown.

The Ministry of Public Health contributes to this program, and will aid in further plans, such as the preparation of brochures on prophylaxis and instructive leaflets on the prevention and prompt care of disease which may possibly result in cancer of the throat.

HIGBEE.

MISCELLANEOUS

Barium in Hydrogen Peroxide in Esophageal and Gastric Diagnosis.

Gianturco, Cesare, and Miller, George A.: Radiol. 65:4:569-571 (Oct.) 1955.

The authors cite their experience with the Paavo Klami technique of using barium suspended in hydrogen peroxide as a contrast medium in radiographic diagnosis of upper gastrointestinal lesions. This medium may be considered "pathology-sensitive" because of its "bubbling effect" in the presence of an ulcerative lesion. Probably the best indication for its use is in ulcerations of the lower esophagus and cardiac portion of the stomach. Five radiographs are shown.

JORSTAD.

Hodgkin's Disease.

Healy, Romeyn J., Col. M. C., Amory, Harold I., Col. M. C., and Friedman, Milton, M.D.: Jour. of Radiol. 64:1:51-55 (Jan.) 1955.

The authors review 216 cases of Hodgkin's disease. They conclude that this disease follows a clinical course typical of a malignant neoplasm and therefore emphasize the importance of early incisional biopsy for histologic diagnosis followed by aggressive x-ray irradiation as preferred treatment.

In 74 per cent of their cases the first sign of disease was enlargement of a cervical lymph node. This constancy suggests unicentric origin.

Principles of x-radiation as applied to the clinical stages of the disease is outlined. Eight tables depict percentages of age and sex

incidence, sites of initial adenopathy, organ involvement, stages of disease and survival rates based on various factors. The absolute five year survival rate was 37 per cent and ten years was 6 per cent. Twelve references are cited.

JORSTAD.

Regarding Two Cases of Congenital Macroglossia.

Georgacopoulos, A.: Revue de Laryngol., Otol. et Rhinol. 75:7-8:548, 1954.

The author reports two cases of congenital macroglossia with enlargement of the tongue sufficient to cause deformation of the teeth and the mandible requiring operation. By means of a V-shaped incision the tip of the tongue was removed and the lateral portions were brought together to form a new tip. Bleeding was reported to be slight and the results perfect.

Mucoceles of the Anterior Ethmoids.

Wild, C., and Klotz, G.: Revue de Laryngol., Otol. et Rhinol. 75:9-10:663, 1954.

The authors discuss the subject of mucoceles at length and vary their treatment according to the extent of the mucocele. They regard what they call "partial" forms, localized in the turbinated bones or the bulla, as amenable to intranasal surgery. When cells anterior to the uncinate process are involved they recommend external approach through the orbit. They advise the external approach for most generalized involvements.

Facial Pain With Bony Condensation.

Andrieu-Guitrancourt, J. B., and Laumonier, René: Les Annales D'Oto-laryngologie 72:4:292, 1955.

The authors report their observations in 96 cases of facial pain and deduct certain anatomical-clinical patterns. They describe the pain as continuing with recurrences set off by vasomotor disturbances, without pain on pressure over the arteries. The syndrome is found particularly in patients troubled with circulatory disturbances of the extremities, venous hypotension and ovarian dysfunction but disturbances of calcium metabolism are not present. Distrophy of the bones suggested by the x-rays and demonstrated by biopsy is con-

stantly encountered. There are no accompanying signs of inflammation.

The picture does not resemble the pains of infectious, allergic or endocrine origin but is more like the vasomotor pain associated with arterial constriction and capillary dilatation, but differs from the latter in the absence of pain over the arterial trunks. The authors regard the pain as being neither osseous nor vascular so far as the large vessels are concerned but believe it is due to the vasodilatation of the capillaries mucosa.

Leprosy. General Views and Points Particularly Related to Otorhinolaryngology.

Guns, P., and Lechat, M.: Les Annales D'Oto-laryngologie 72:4:272, 1955.

After a brief historical and etiological review, the authors describe the general symptoms and appearance of an individual afflicted with the disease and proceeds at some length to the involvement of the ear, nose and throat. Prominently are mentioned nodules and ulcerations at the level of the pharynx eventuating in a progressive loss of tissues and the formation of "vicious" cicatrices. At the level of the larynx the lesions are usually tuberculoid and co-exist often with anesthetic lesions at the level of the pharynx and the palate. The process proceeds from nodules to infiltrations, ulcerations and finally cicatrization. While the vocal cords remain for a long time intact, the voice is rendered nasal by the destruction of the surrounding pharyngeal tissues and the speech is modified by the presence of lesions in the lips and the tongue. Dyspnoea slowly develops but does not become serious for a number of years. These are the classic lesions. In the center of more than a thousand patients the authors have not encountered more than a few lesions at the level of the larynx and the pharynx. This they attribute to treatment through sulfonamides which rapidly arrest the extension of the malady.

The nose is the organ most often attacked. Progress here is usually divided into two periods. The period of invasion characterized by a serous rhinitis with frequent epistaxis has not been encountered by them in the leper colony. They have encountered the later stage consisting of a considerable tumefaction of the mucosa, with a purulent rhinitis. The second stage shows a pale mucosa, atrophic and dry, but without crusts or odor. The turbinates are less often affected than the septum, and nasal anesthesia is frequent. The sinuses are rarely invaded.

There follows a statistical, tabulated study of 27 cases.

The treatment employed has been diamino diphenylsulfone (sulanilamide), with which very satisfactory results are reported.

Bilateral Bronchography.

Gianturco, Ceasare, and Miller, George A.: Radiol. 65:1:57-61 (July) 1955.

The authors describe a new technique with the use of "Dionosil oily"® for complete bilateral bronchography. This medium has been used in England and South America for two years. It is rapidly injected into the trachea in such a manner that the mouths of all bronchi are covered at once, and the fluid is aspirated uniformly throughout the periphery of the bronchial tree. In 25 bilateral bronchograms the authors conclude that this technique has made the procedure relatively simple and reliable and avoided the persistent "lung stain" so often seen after the use of iodized oils. Four views of the instrument used for tracheal catheterization and one bronchogram are shown.

JORSTAD.

Interpretation of Vestibular Tests.

Gros, J. C.: Rev. Cubana Oto-Rino-Laringol. 4:1:17-27, 1955.

The vestibular reflex, which occurs in the diagnosis of disturbances of the labyrinth, consists of nystagmus, vertigo and abnormalities in voluntary movements. The reflex can be elicited by cold or hot water tests, rotation, or by galvanic current.

Spontaneous nystagmus is usually horizontal and may indicate tumors, multiple sclerosis, occasionally syphilis, arachnoiditis, or hydrocephalus. Rotatory nystagmus indicates lesions of the posterior fossa, bulbar nuclei, or cerebellar damage. Vertical nystagmus is rare, but may be observed in multiple sclerosis, syringobulbia, and high bulbar lesions. Horizontal-rotatory nystagmus is most common in peripheral labyrinthine lesions, or in those of the cerebello-pontine angle. Multiple nystagmus occurs in multiple sclerosis, tumors of the cerebello-pontine angle, or of the fourth ventricle. A change in intensity and direction with alteration of the position of the head usually indicates subtentorial lesions. Changes in the frequency but not in the direction of the nystagmus, with varying positions, point to supretentorial lesions, especially in the temporal lobe. Postural nystagmus is explained by circulatory changes related to the position

of the head. Pendulatory nystagmus may be hereditary, as in blindness or in congenital cataract. Acquired pendulous nystagmus has been observed in multiple sclerosis and in lesions of the callosal peduncle. Spontaneous nystagmus of peripheral origin is always directed toward the normal side.

Deviation of the index finger is always a sign of irritation of the vestibular pathway especially of the first neurone from the labyrinth to the vestibular nuclei. Unilateral deviation is frequent in lesions of the posterior fossa especially in tumors of the cerebello-pontine angle. In lesions of the frontal lobe the contralateral extremity is affected, the elbow is flexed, and the index finger is deviated inward.

Nystagmus of peripheral origin is always rotatory and intermittent, recurring when the head is turned. Vertigo of central origin results in lateral, backward or forward inclination on walking.

Spontaneous vestibular symptoms associated with homolateral paralysis of the pharynx or larynx may occur in lesions of the cerebello-pontine angle. Nystagmus with homolateral paralysis always indicates cavities in the medulla oblongata.

The peripheral syndrome consist in rotatory nystagmus, horizontal-rotatory nystagmus toward the normal side, bilateral deviation of the finger in the direction of the slow movement of the eye, positive Romberg varying with the position of the head, occasionally facial paralysis. The symptoms are intermittent. This syndrome is found in suppurative labyrinthitis, Ménière's disease, trauma of the petrous body, syphilitic neurolabyrinthitis, and in psychic disturbances.

In the central vestibular syndrome the deviation of the finger and the Romberg sign are in the direction of the rapid jerk of the eyeball. Absence of the rapid jerk of the nystagmus, so that the eyeball turns into the palpebral angle and can be moved back only by voluntary effort indicates lesion of the posterior longitudinal bundle, heredo-ataxia, or tumor of the protuberance. Hyperexcitability is observed in both peripheral and central lesions. Lack of excitability may be unilateral or bilateral. If the unilateral type is associated with homolateral deafness, the cause may be tumor of the auditory nerve, cholesteatoma, or aneurysm.

The vestibulocerebellar syndrome and that due to lesion of the fourth ventricle include spontaneous vertical nystagmus, inclination of the head toward the shoulder, and rotation toward the other side, backward swaying of the body, and weakness of the legs.

HIGBEE.

Modern Theories Regarding the Physiology of Phonation.

Gros, J. C.: Rev. Cubana Oto-Rino-Laringol. 4:1:10-16, 1955.

Modern research has established the theory of neuromuscular rhythmic activity as the physiologic basis of phonation. This has an important bearing on the treatment of vocal disturbances. Phonation is not merely a localized peripheral phenomenon limited to the larynx and dependent upon the vibratory frequency of the vocal cords. It reflects the psychic status of the patient. The larynx is a neuromuscular mechanism which responds to each action potential transmitted by the recurrent nerve and its cortical neurones, by vibration of the cords. The frequencies of vibration in the female range from 60 (contralto) to 1,300 (soprano), in exceptional cases to 2,320 vibrations per second. The conduction of an action potential by a motor fiber axone has four phases: inexcitability (0.002 sec.), excitability (0.0015 sec.), intense activity (0.0115 sec.), and decreasing activity (0.085 sec.). The axones of the recurrent nerve form two groups, which alternate in transmitting biphasic vibrations. At 652 vibrations (second vocal register, when the voice changes from chest to falsetto tones), an interval intervenes between two successive impulses. If this interval is less than 0.001 seconds, the new impulse falls into the period of inexcitability of the preceding two, and the fibers of the recurrent nerve assume a triphasic rhythm between 1,000 and 1,500 vibrations. Beyond this range quadriphasic conduction occurs. These polyphasic successive rhythms are integrated, just as they are in the activity of the cortical centers which control the auditory function.

The cerebral stimulation is related to the sodium, calcium and potassium ion metabolism, and to the activation of the thyroid and suprarenal hormones involved in their metabolism. The three centers of stimulation, each with characteristic frequencies and reflexes, are cortical, diencephalic and bulbar. The cortical center integrates rhythmic activity with the vibrations and determines the selected tone to be produced. The diencephalic center is affected by emotional states such as happiness, sadness and anxiety. Emotional factors affect the endocrine functions. Thyroid deficiency results in modulations of the speaking voice and in difficulties in maintaining tones, while an excess of the hormone causes overstimulation of the nervous system with rapid vocal fatigue and phonasthenic syndromes. Parathyroid insufficiency affects the calcium metabolism. For this reason, calcium medication is indicated for singers whose vocal expression is spasmodic, and who have a sensation of laryngeal oppression. Sex hormones affect the tones of adolescence and old age and determine the difference between male and female voices.

All of these influence the rhythmic contractions of the transverse fibers of the thyroarytenoid, and therefore the movements of the vocal cords. In view of these findings, the remedies formerly used: atomizers, aconite, topical applications, belladonna, etc., are definitely out-moded.

HIGBEE.

Books Received

An Atlas of Otolaryngic Pathology.

By Colonel J. E. Ash, M.C. (Ret.) and Muriel Raum, M.D. xi, 572 pp., profusely illustrated, price $20.00. American Registry of Pathology, Washington, D.C., 1956.

Diseases of the Chest.

By H. Corwin Hinshal, M.D., Clinical Professor of Medicine, Stanford University School of Medicine, and L. Henry Garland, M.B., Clinical Professor of Radiology, Stanford University School of Medicine. x, 727 pp., illustrated, W. B. Saunders Co., Philadelphia, 1956, price $15.00.

A Stereoscopic Atlas of Human Anatomy. Section III. The Upper Extremity.

By David L. Bassett, M.D., Associate Professor of Anatomy, Stanford University, California. Photographs by William B. Gruber. Atlas and 28 reels (196 pairs of stereoscopic films) with index. Three volumes, 8vo., loose-leaf, composition covers. Sawyer's Inc., Portland, Oregon.

Speech After Laryngectomy.

By Louis M. di Carlo, Walter W. Amster and Gilbert R. Herer, Syracuse University. Cloth, 8vo., xxiii, 184 pp., illustrated. Syracuse University Press, Syracuse, N. Y., 1955, price $4.00.

The Human Adrenal Cortex (Ciba Foundation Colloquia on Endocrinology, Vol. III).

Edited for the Ciba Foundation by G. E. W. Wolstenholme, O.B.E., M.A., M.B., B.Ch., and Margaret P. Cameron, M.A., A.B.L.S., Gregory Pincus, M.D., Director of Laboratories, Worcester Foundation for Experimental Biology, Chairman for Part I, and Dr. George W. Thorn, M.D., Physician-in-Chief, Peter Bent Brigham Hospital, Chairman, Part II. 8vo., cloth, 665 pp., illustrated. Little, Brown and Company, Boston, 1955, price $10.00.

Ageing—General Aspects (Ciba Fundation Colloquia on Ageing).

Edited for the Ciba Foundation by G. E. W. Wolstenholme, O.B.E., M.A., M.B., B.Ch., and Margaret P. Cameron, M.A., A.B.L.S., assisted by Joan Etherington. 8vo., cloth, 247 pp., 38 illustrations. Little, Brown and Co., Boston, 1955, price $6.75.

Voice and Speech Patterns of the Hard of Hearing.

By Jacques Paul Penn, Ph.D. Supplementum 124, Acta Oto-laryngologica, 1955, 69 pp.

Functional Otology, The Practice of Audiology.

By Morris F. Heller, M.D., with Bernard M. Anderman and Ellis E. Singer. 225 pp., 30 illustrations, cloth, 8vo. Springer Publishing Co., N. Y., price $5.50.

The Voice of Neurosis.

By Paul J. Moses, M.D., Assistant Clinical Professor in Charge of Speech and Voice Section, Division of Otolaryngology, Stanford University School of Medicine, San Francisco, Calif. Cloth, 131 pp. Grune and Stratton, New York, 1954.

Rontgenaufnahmetechnik in der Hals-Nasen-Ohrenheilkunde (X-ray Technique in Throat, Nose and Ear).

By Dr. B. Schlosshauer, Hamburg. 1956, viii, 48 pp., 72 illustrations, paper 8vo. (In German). Georg Thieme Verlag, price $2.85.

Faringostomi Postoperatori, Metodi e Risultati di Restaurazione Plastica. (Postoperative Pharyngostomes, Methods and Results of Plastic Restorations).

By Dr. Leopoldo Bosio, University of Milan. 31 pp. and 52 illustrations, some in color; paper, large 8vo. Supplement XXV, 1955, Archivio Italiano di Otologia Rinologia e Laringologia, Milan (In Italian).

Modificazioni e Destino Degli Innesti Endauricolari di Lembi Liberi Cutanei e Mucosi (Modifications and Fate of Endauricular Skin and Mucosal Grafts).

By Modesto Negri. 87 pp., with 56 illustrations; paper, large 8vo. Supplement XXII, 1955, Archivio Italiano di Otologia Rinologia e Laringologia, Milan (In Italian).

La Broncografia nel Bambino (Bronchography in the Infant).

By Lucio Parenzan and Alfredo Vago. 304 pp., 195 illustrations, large 8vo., paper. Supplement XXIII, 1955, Archivio Italiano di Otologia, Rinologia e Laringologia. (In Italian)

SIXTH INTERNATIONAL CONGRESS OF OTOLARYNGOLOGY

MEETING: WASHINGTON, D. C., U. S. A. - MAY 5-10, 1957

At the request of the Sixth International Congress of Otolaryngology, the American Express Company has arranged three post-Congress tours which will begin May 11, 1957, immediately after the close of the Congress. The tours will run concurrently and each will be accompanied by an American Express Tour Escort. All three will be in Philadelphia at the time of the Sixth International Congress of Bronchoesophagology, May 12 and 13, 1957. Tours 2 and 3 will be in St. Louis at the time of the International Conference on Audiology, May 14, 15 and 16, 1957, and Tour 2 will be in Chicago at the time of the International Voice Conference, May 20, 21 and 22, 1957. Other scientific events and a full social program are planned for the major cities visited. The itineraries for the tours are as follows:

TOUR 1 (Eastern U.S.): 7 days. Cost $212.00 plus $4.10 Federal Transportation Tax. Cities to be visited include Baltimore, Philadelphia, Boston and New York.

TOUR 2 (Middle West): 17 days. Cost $638.00 plus $15.98 Federal Transportation Tax. Cities to be visited: Baltimore, Philadelphia, St. Louis, Iowa City, Rochester (Minn.), Chicago, Detroit, Niagara Falls, Boston, New York.

TOUR 3 (West Coast): 3 weeks. Cost $838.00 plus $30.47 Federal Transportation Tax. Cities to be visited: Baltimore, Philadelphia, St. Louis, Grand Canyon, Los Angeles, San Francisco, Chicago, Niagara Falls, New York.

The prices given include transportation, Pullman and hotel accommodations, meals and handling of baggage. Individuals from overseas who purchase tours abroad will be exempt from payment of the Federal Transportation Tax.

For detailed information and complete itineraries communicate with the General Secretary, Sixth International Congress of Otolaryngology, 700 N. Michigan Ave., Chicago 11, Ill., U.S.A.

Notices

AMERICAN LARYNGOLOGICAL ASSOCIATION

Copies of the Transactions of the American Laryngological Association are available for general distribution at $8.00 a copy. Please send request with check to:

Dr. Edwin N. Broyles,
Editor Transactions
1100 North Charles St.
Baltimore 1, Md.

ACADEMY HOME STUDY COURSES

The 1956-1957 Home Study Courses in the basic sciences related to ophthalmology and otolaryngology, which are offered as a part of the educational program of the American Academy of Ophthalmology and Otolaryngology, will begin on September 1 and continue for a period of ten months. Detailed information and application forms can be secured from Dr. William L. Benedict, the executive secretary-treasurer of the Academy, 100 First Avenue Building, Rochester, Minnesota. Registrations should be completed before August 15.

WASHINGTON UNIVERSITY

The Department of Otolaryngology, Washington University, Saint Louis, offers a Basic Science Course in Otolaryngology to start on Monday, September 17, 1956. Complete information about the course may be obtained by writing to the Head of the Department of Otolaryngology, 640 S. Kingshighway, St. Louis 10, Missouri.

TULANE UNIVERSITY OF LOUISIANA
SCHOOL OF MEDICINE

The three year residency in otolaryngology offered at Charity Hospital of Louisiana at New Orleans on the Tulane University of Louisiana School of Medicine service is designed to qualify the holder for the examinations of the American Board of Otolaryngology and the practice of all phases of otolaryngology and endscopy.

Candidates must be graduates of a class A medical school and must have completed a minimum of one year of general internship. An additional year of residency in internal medicine or general surgery is desirable but not essential.

All work is under the direct supervision of members of the Tulane Department of Otolaryngology, who are also members of the Charity Hospital Otolaryngological Staff; they are available at all times for instruction and guidance. Basic sciences are offered throughout each year of the residency during the academic year. The resident also participates in the program of the Speech and Hearing Center at the Tulane University School of Medicine.

The hospital year extends from July 1 of one year to June 30 of the following year.

Applications should be addressed to the Chairman of the Department of Otolaryngology, Tulane University of Louisiana School of Medicine, 1430 Tulane Ave., New Orleans 12, Louisiana.

TEMPLE UNIVERSITY
SCHOOL OF MEDICINE AND HOSPITAL

The following courses are all to be given in the Department of Laryngology and Broncho-Esophagology, Temple University Hospital and School of Medicine, under the direction of Drs. Chevalier L. Jackson and Charles M. Norris:

Postgraduate Course in Broncho-Esophagology, February 6-17, 1956; May 28-June 8, 1956; September 17-28, 1956.

Postgraduate Course in Laryngology and Laryngeal Surgery, April 23-May 4, 1956; November 5-16, 1956.

The tuition fee for each course is $250.00.

Further information and application blanks can be obtained from Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40, Pa.

UNIVERSITY OF INDIANA

The Department of Otolaryngology, Indiana University School of Medicine, offers its annual Anatomical and Clinical Course in Otolaryngology March 26 to April 7, 1956.

Applicants should address The Post-Graduate Office, Indiana University Medical Center, Indianapolis 7, Indiana.

VIRGINIA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

The Virginia Society of Ophthalmology and Otolaryngology is sponsoring a convention cruise to Havana and Nassau on May 26 to June 2, 1946. Sailing from and returning to Norfolk, Virginia, the "Queen of Bermuda" will act as the hotel for the trip. Fare for seven days, $165.00 and up per person. Please make reservations with the United States Travel Agency, Inc., Washington, D.C.

COLLEGIUM OTO-RHINO-LARYNGOLOGICUM AMICITIAE SACRUM

The Shambaugh Prize of the Collegium Oto-rhino-laryngologicum for 1955 has been awarded to Charles Skinner Hallpike of London in recognition of his outstanding research on the vestibular and acoustic labyrinth.

The Shambaugh Prize was founded in memory of the late Dr. George E. Shambaugh, Sr. by his family and is awarded every second year. Previous recipients of the prize are Dr. G. von Békésy, Dr. Raoul Caussé and Dr. Hallowell Davis.

CLEVELAND OTOLARYNGOLOGICAL SOCIETY

Saint Luke's Hospital and The Cleveland Otolaryngological Society will present a postgraduate course, including several distinguished speakers, at Prentiss Auditorium, Cleveland, May 9, 1956. For particulars please address Mrs. Elizabeth D. Alexander, 11311 Shaker Boulevard, Cleveland 4, Ohio.

BIBLIOGRAPHY OF MEDICAL REVIEWS

The Armed Forces Medical Library announces the publication in May of a *Bibliography of Medical Reviews.*

The bibliography, arranged by subject, will contain approximately 800 references to review articles in clinical and experimental medicine and allied fields which have appeared in the calendar year 1955.

Copies of the *Bibliography of Medical Reviews* will be available upon request to the Director, Armed Forces Medical Library, 7th Street and Independence Avenue, Southwest, Washington 25, D. C. in the order of receipt.

OFFICERS

OF THE

NATIONAL OTOLARYNGOLOGICAL SOCIETIES

American Academy of Ophthalmology and Otolaryngology

President: Dr. Algernon B. Reese, New York.
Executive Secretary: Dr. William L. Benedict, Mayo Clinic, Rochester, Minn.

American Board of Otolaryngology

President: Dr. Frederick T. Hill, Professional Bldg., Waterville, Maine.
Secretary: Dr. Dean M. Lierle, University Hospital, Iowa City, Iowa.
Next examination: Montreal, May 7-10, 1956.

American Broncho-Esophagological Association

President: Dr. Daniel S. Cunning, 115 E. 65th St., New York 21, N. Y.
Secretary: Dr. F. Johnson Putney, 1719 Rittenhouse Sq., Philadelphia 3, Pa.
Meeting: Mount Royal Hotel, Montreal, May 15-16, 1956.

American Laryngological Association

President: Dr. Bernard J. McMahon, St. Louis.
Secretary: Dr. Harry P. Schenck, 326 South 19th St., Philadelphia, Pa.
Meeting: Seigniory Club, Montreal, May 13-14, 1956.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. Dean M. Lierle, Iowa City.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester, N. Y.
Meeting: Mount Royal Hotel, Montreal, May, 1956.

American Medical Association, Section on Laryngology, Otology and Rhinology

Chairman: Dr. John R. Lindsay, Chicago, Ill.
Secretary: Dr. Hugh A. Kuhn, Hammond, Ind.

American Otological Society

President: William J. McNally, M.D., 1509 Sherbrooke Street West, Montreal 25, Quebec, Canada.
Secretary-Treasurer: Lawrence R. Boies, M.D., University of Minnesota Hospitals, Minneapolis 14, Minnesota.
Meeting: Seigniory Club, Montreal, Quebec, Canada, May 11-12, 1956.

The American Society of Ophthalmologic and Otolaryngologic Allergy

President: Dean McAllister Lierle, M.D., University Hospital, Iowa City, Iowa.
Secretary: Michael H. Barone, M.D., 468 Delaware Avenue, Buffalo 2, New York.

VI International Congress of Otolaryngology

President: Arthur W. Proetz, M.D., St. Louis, U. S. A.
Secretary-General: Paul H. Holinger, M.D., 700 North Michigan Ave., Chicago 11, Ill., U. S. A.
Meeting: Washington, D. C., May 5-10, 1957.

International Bronchoesophagological Society

President: Dr. Antonio da Costa Quinta, Lisbon, Portugal.
Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40, Pa.

Pan-American Association of Oto-Rhino-Laryngology and Broncho-Esophagology

President: Dr. Juan M. Tato, Buenos Aires.
Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40, Pa.
President of the Congress: Dr. J. H. Font, Puerto Rico.
Secretary of the Congress: Dr. C. E. Muñoz MacCormick, Santurce 29, Puerto Rico.
Meeting: San Juan, April 8-12, 1956.

Pacific Coast Oto-Ophthalmological Society

President: Lester T. Jones, M.D., 624 Medical Arts Bldg., Portland 5, Oregon.
Secretary-Treasurer: John F. Tolan, M.D., 3419 47th Ave., N.E., Seattle 5, Wash.